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French and Swiss Turbines in Modern Water Power Electric Plants.

Due probably to the peculiar conditions existing in Continental Europe, and particularly in Switzerland, many of the important details of construction of water wheels and turbines have been originally developed and introduced in the mountains of France and Switzerland. The turbines which have been designed for the particular use of these and other European countries, have been reconstructed, and in some cases redesigned for American application. It has only been within the last decade that turbines, and even water wheels of any type, have been built to meet the exacting requirements of driving electrical machinery. The necessity of absolutely continuous operation, as well as the nicety with which the speed must be regulated, caused turbines to be modified materially as regards their mechanical details, particularly for very large units.

The following article has been prepared with the intention of setting forth some of the recent developments in foreign built turbines. Similar machines as now built in America, will be described in a second article. There has been no attempt, however, to cover the entire field of European manufacture in this line of water wheel machinery.

The Bournillon electric power plant, owned and operated by the Societe des Forces Motrices du Vercors, is equipped with turbines of the French and Swiss design, these turbines having horizontal shafts and directly connected to the electrical generators. Vertically driven alternators and turbines are extensively used both in France and Switzerland, the vertical shaft type being more largely used in electric power stations, operating under a low head and using large quantities of water.

In the Bournillon station there are in operation three of the horizontal type turbines, each of which has a capacity of 1,250 horsepower. The alternators are of the revolving field type and were furnished by Schneider & Cie of Creusot. Fig. 1 gives a clear idea of the arrangement of the station and serves to show some of the details of the turbines themselves.

Fig. 2 is a view looking at the opposite side of one of the turbines as shown in the general view of the station. The

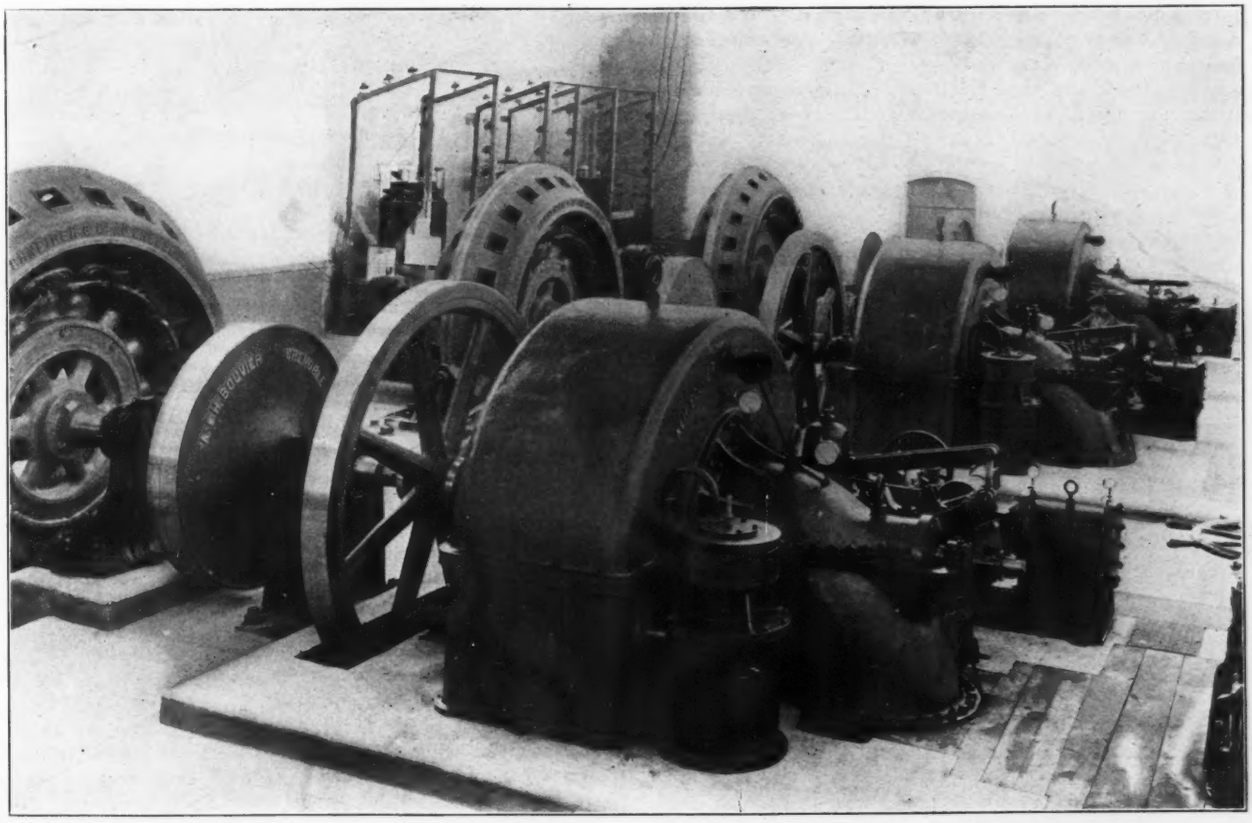

Fig. 1.—Interior of Bournillon Power Station.

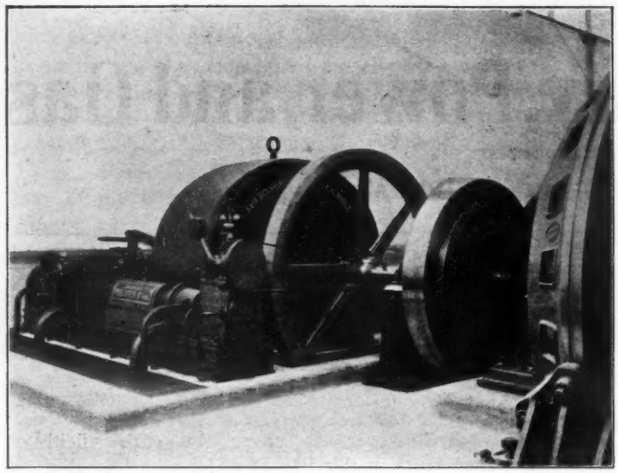

Fig. 2.—Servo Motor and Automatic Regulator in the Bournillon Power Station.

arrangement and method of operation of the Servo motor and automatic regulator is well illustrated.

Another interesting detail of this plant is shown in Fig. 3, being the central regulating apparatus of the Bouvier type. The turbines operate under a head of 98 meters (293 feet) the speed being 375 revolutions per minute. They were built and installed by A. & H. Bouvier of Grenoble, France. The output of this station is utilized at the Stadt Vienne for both electric light and power.

The special type of regulating apparatus installed at this plant is very effective in controlling the speed, notwithstanding wide variations in the load. This type of governor is said to regulate so closely that the variation is only 13 revolutions when a load of 1000 horse power is instantly switched off from the alternator. If 900 horse power is suddenly added to the load or cut off, the variation does not exceed 12 revolutions per minute. A change of 670 horse power in the load corresponds to a fluctuation of speed of 9 revolutions per minute, while 500 horse power effects the speed but 6 revolutions per minute. The difficulty of maintaining practically constant speed with wide variations of load for turbines operating under this head is well known. The mechanical energy required to produce a change in the amount of water delivered to the wheel is very great, and as this must be done in a very short time, the regulating mechanism must be of generous dimensions. Such changes must at the same time be quickly accomplished and the use of the central regulating apparatus is somewhat unique in such turbine plants.

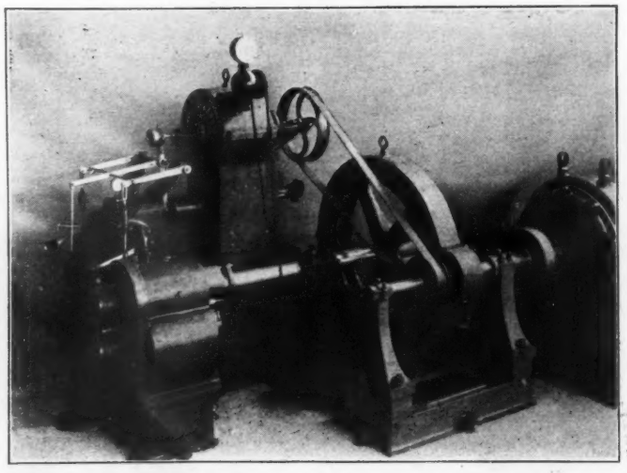

Fig. 3.—Central Regulating Apparatus in the Bournillon Power Station.

An interesting, although small turbine of the Francis type, is in use at the plant of Messieurs les Heritiers de Georges Perrin at Cornimont Voseges, France. This turbine was installed by J. J. Rieter & Co., of Winterthur, Switzerland, and has a capacity of 185 horse power and is illustrated in Fig. 4. It is of the horizontal shaft type and is designed for rope drive. The normal speed is 257 revolutions per minute. The effective head under which it works is 10 meters (33 feet), and the amount of water required at full load is about 1,800 liters (63 cubic feet) per second.

A quadruple turbine of an entirely different design is in use at the power station of the Societe Anonyme la Hydro-Electrica at Anzaniga, in Spain. The four wheels have a common shaft and two draft tubes, one for each pair of wheels. Fig. 5 shows the revolving parts and the guides and cast iron heads of the draft tubes. This station operates under a head of 20 meters (66 feet), the speed being 400 revolutions per minute. Each turbine develops 120 brake horse power, using 600 liters (21 cubic feet) of water per second.

Three large Rieter Francis turbines are in operation at the water power plant at Pians in Tyrol, Austria, one of them being shown in Fig. 6. The normal capacity of this turbine is 1,500 horse power at a speed of 300 revolutions per minute, the effective head being 88 meters (290 feet), and at full

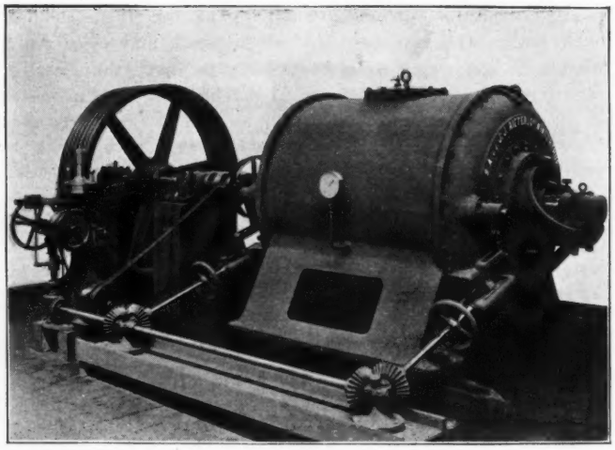

Fig. 4.—Rieter-Francis Turbine.

load the amount of water required is approximately 1,700 liters (59.5 cubic feet) per second.

A large number of different types of smaller turbines of the Francis type have been designed and built by Rieter & Co. One of particularly compact and pleasing form is shown in Fig. 7, and is installed at the power station of l'Union Cuvriers at Abbaye-Vallorbes, Switzerland. The effective head is but 10.5 meters (34.6 feet), and is so designed as to receive water below the horizontal shaft and discharge radially, somewhat similar to the ordinary centrifugal pump, if operated backwards. This small turbine develops 25 horse power at 490 revolutions per minute. At full head 200 liters (7 cubic feet) of water is required per second. There is a Francis turbine installed at the plant of Handschin & Ronus at Liesthal, Switzerland, which, while of the same construction, as the above, differs from it in that the water is taken in above the shaft, but discharges radially in the same manner. The head is 9.55 meters (31.5 feet) and the speed 260 revolutions per minute. The output is but 30 horse power, with 315 liters (11 cubic feet) of water per second.

At Rheinsfelden a quite different form of Francis turbine is installed, the turbine being from designs of J. Ehrismann. This turbine has a capacity of 50 horse power, the effective head being 4.1 meters (13.5 feet), the speed 118 revolutions per minute, using 1,200 liters (42 cubic feet) of water per second. Another horizontal shaft Francis turbine of the

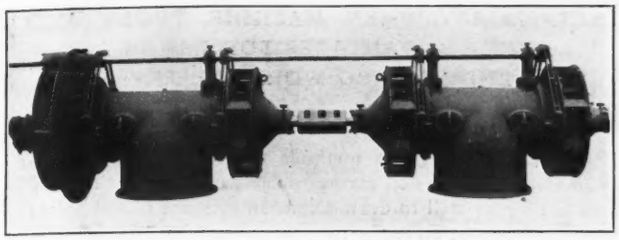

Fig. 5.—Quadruple Rieter-Francis Turbine.

same general type is installed at the plant of the Societe Vaudoise de Filature et Tissage de Galand, Switzerland, and is constructed as a single turbine in a conical iron casing, the water discharging from the center radially. This turbine has a maximum capacity of 75 horse power under an effective head of 9 meters (29.7 feet), using 800 liters (28 cubic feet) of water per second, the speed being 240 revolutions per minute.

Included in all the forms of horizontal turbines there are the following types:

No. 1—The single turbines in iron wheel case.

No. 2—The single turbine in open penstock.

No. 3—The double turbine discharging into separate draft tubes.

No. 4—The double turbine discharging into one draft tube.

A slightly different form of the Francis turbine of the horizontal type, from those described above, is the Rieter turbine at the plant of Salzmann & Daniker, at Glattfelden, Switzerland. This wheel has a capacity of 130 horse power, and a speed of 200 revolutions per minute when operating under a head of from 4.45 to 4.65 meters (14.7 to 15.3 feet) and using 300 liters (10.5 cubic feet) of water per second. An excellent illustration of this turbine is given in Fig. 8.

Reiter turbines of the Girard and Pelton (or impulse) type have been used extensively in the mountains of both Switzerland and Italy, where the effective head is high. Three turbines, each of 300 horse power capacity, of the Girard type, are installed in the plant of the Societa Idroelettrica della Valle Imagna Inferiore at Bergamo, Italy. They are directly connected to alternators and operate under an effective head of 80 meters (264 feet) the speed being 500 revolutions per minute, using 375 liters (13 cubic feet) of water per second. The governors in this plant are of the Reiter type and serve to control the speed within very narrow limits, even at excessive variation of the load. The exciters are directly connected to the main turbines, being driven by the same shaft and mounted just outside the main bearing of the main generator. This turbine and the governing mechanism are illustrated in Fig. 9.

Another installation in Italy, using turbines of the Girard type, is that of the Societa Montegalese de Electricita at

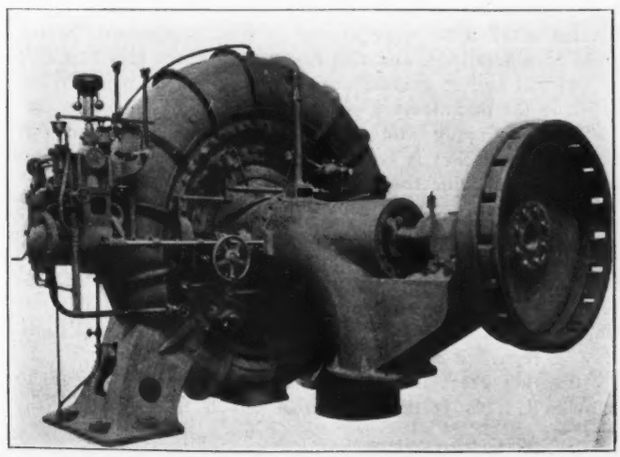

Fig. 6—1500-Horsepower 300-Revolution-Per-Minute Rieter-Francis Turbine at Plans.

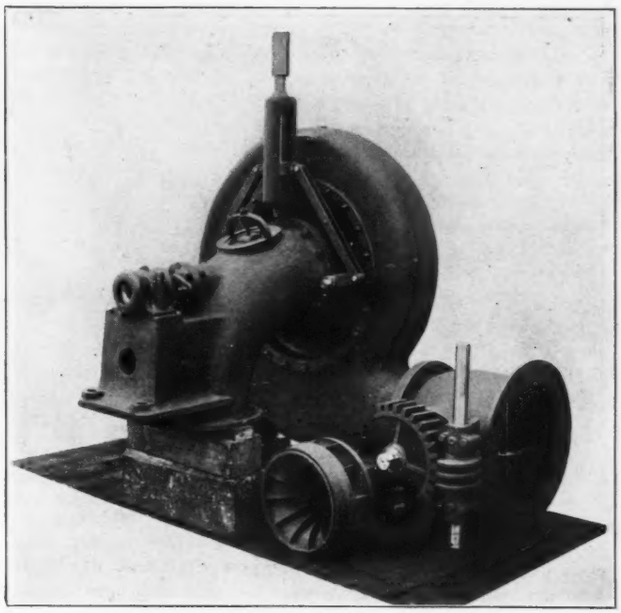

Fig. 7—Rieter-Francis Turbine at the Plant.

Mondovi. These turbines have a capacity of 200 horse power, the speed being 500 revolutions per minute, the effective head is 95 meters (313 feet), and at full load the amount of water used is approximately 210 liters (7.3 cubic feet) per second. One of these turbines completely equipped with the governing mechanism is illustrated in Fig. 10.

One of the conspicuous plants in Switzerland, using turbines of the Francis and Girard types, is at Lauterbrunnen, where current is generated for the operation of the Chemin-de-Fer-de la Jungfrau. The exciters in this plant are driven by Reiter Girard turbines, running under a load of 35 meters (115 feet). The exciters run at a speed of 700 revolutions per minute, being directly connected to these water wheels which develop 25 horse power each, using 72 liters (2.5 cubic feet) of water per second. The main turbines in this plant are of two types, the Francis and the twin Girard. The two Girard turbines, which have a capacity of 500 horse power each, are of the twin design with axial flow. The effective head is 115 feet, the speed 380 revolutions per minute, full load requiring 42 cubic feet of water per second. The generators which are directly driven by these turbines are of the Oerlikon inductor type, generating a three-phase current at a frequency of 38 cycles per second and a voltage of 7,000 volts.

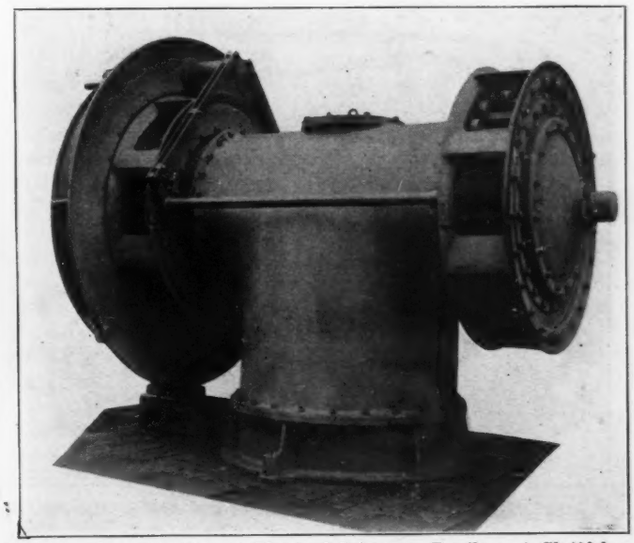

Fig. 8.—Rieter Turbine at Plant of Salzmann-Daniker at Glattfelden, Switzerland.

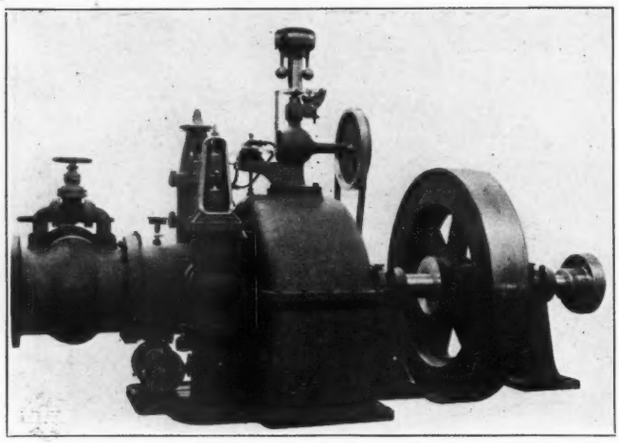

Fig. 9.—300-Horsepower Turbine of the Girard Type at Plant of Societa Idroelettrica della Valle Imagna Inferiore at Bergamo, Italy.

There are two other turbines installed in the plant, each of which develops 800 horsepower. These are of the Francis type and operate under an effective head of 32.5 meters (107 feet) at a speed of 380 revolutions per minute. At full load 2,500 liters (87.5 cubic feet) of water are used per second. The same type of alternators are directly driven by these turbines, their armatures having 72 slots with 36 coils, two slots per pole and per phase. Each winding has 20 conductors of two wires in parallel, measuring 3.8 mm. by 4.4 mm. in area. The field magnet winding consists of 350 turns of copper conductor 8 mm. by 8.6 mm. in cross section.

Two distinct sources of water supply these turbines, the Weisse Latschine, with a capacity of 2,650 horsepower and a flow of 6 cubic meters (212 cubic feet) per second, and the Schwarze Lutchine, with a capacity of 2,000 horsepower, the flow being 17½ cubic meters per second. The Weisse Lutchine at Lauterbrunnen has already been developed, the water power of the Schwarze Lutchine in Burglauen being as yet not utilized. The total fall of 40.8 meters (1,440 cubic feet) is obtained by carrying the water a distance of 1,315 meters (8-10th of a mile or 4,340 feet). The current generated at this plant operates the Jungfrau Electric Railway, which has a maximum grade of 25 per cent and ascends to the summit of the Jungfrau, one of the highest mountain peaks in Switzerland, being 13,670 feet above sea level.

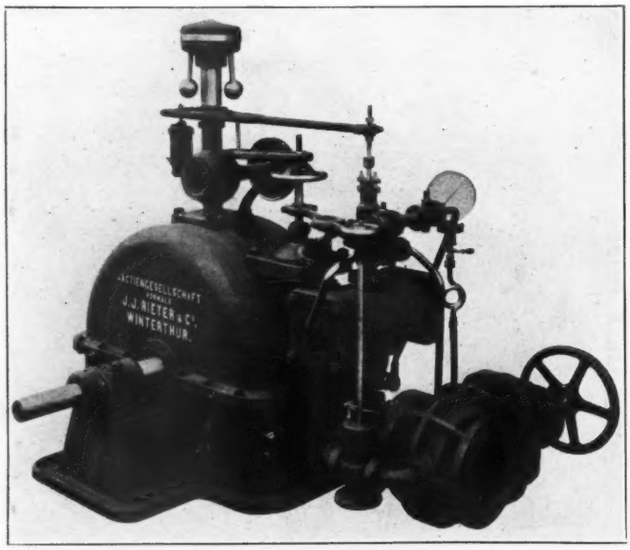

Fig. 10.—Girard Turbine at the Plant of the Societa Montegalese di Elettricta at Mondovi, Italy.

ELECTRICALLY-DRIVEN MACHINE TOOLS, AND THEIR ADVANTAGES FOR USE IN ENGINEERING WORKSHOPS.*

By G. Ralph.

Before describing the methods of gearing and application of electric motors to various purposes in the engineering shops, it may be well to draw attention to some of the points which appeal most strongly to a works manager in favor of electrical driving.

One of the foremost of these is the ease with which machines may be so arranged with reference to one another as to facilitate the "following on" of work from one tool to another, without an excessive amount of handling, either by manual labor or by overhead cranes. Where all the machine tools are driven from line shafting, they must follow a more or less rigid arrangement in lines parallel to the shafting, which is not by any means the most convenient way in many cases, although this arrangement has become so general from years of use that it does not at once strike the casual observer that it is inconvenient.

Many shops are built in two bays, only one of which is served by overhead traveling cranes, while the main shafting is erected in the other bay, and thus most of the machines are collected together in or near that bay. Where the height of the shops is limited, as is often the case when the building has two or more stories, it is impracticable, in many instances, to place machines on the far side of the bay served by the traveling cranes, owing to the difficulty of getting belts across from the line shafting. The author is, of course, aware that this difficulty does not exist in large shops where there is plenty of head room, as a second line shaft can be erected below the traveler gantry on the walls or columns. But one cannot make more head room if it does not exist, and has to make the best of circumstances. In such cases the application of electric motors to individual machines proves of great advantage.

Taking a case which came under the author's notice some time ago as an instance. It used to be necessary to transport all the heavy magnet-castings from the planing-machines at one end of the shop by hand traveling cranes, to a large radial drill at the opposite end. After drilling, these had to be brought back again to the boring machines near the place where they started from. It was decided to move the radial drill from that position to a point about midway between the planing and boring machines on the opposite side of the bay. These large masses of material now only have to be lifted across to the other side of the bay for drilling, and zig-zag back again for boring, instead of being twice carried almost the full length of the shop. This instance gives some idea of the convenience of being able to group machines together in the best manner. It would have been impracticable to drive this radial drill from the line shafting in its new position in this particular case. Several other tools were moved to new positions from the same considerations, and this resulted in much less handling of material and in greater output. Those of us who are engaged in the manufacture of heavy machinery will know that the proper supply and following on of work from one machine to another is second only in importance to the output of the machine tools, from a commercial point of view. As it has been very aptly put in an article by Mr. Hutton, in one of the engineering magazines, "the productive shop, being a tool, can be regarded as a machine, to be designed for a specific purpose. In this design the special tool is the cutting edge, while the internal system of transportation, whereby work is brought and presented to the special tools, may be regarded as the feed motions of the machine."

Another great advantage of applying separate motors to individual tools is the ease with which the speed of the

* A paper read before the Institution of Electrical Engineers of London.

machine can be varied without the necessity of shifting belts on the cone pulleys. The average machine-hand will, in most cases, not take the trouble to shift his belt to suit the size of work unless closely and constantly watched by the foreman; but give him a small regulating switch close to his hand, when he has only to give a knob a quarter turn to increase his speed by 25 or 50 per cent, and he will do it.

Many motors for machine tool driving are so constructed that the speed may be increased to double the normal speed simply by varying the exciting current in the shunt winding, which is, of course, much more efficient than inserting resistance in the main circuit for varying the speed If, in addition to this, the motor-armature be double-wound with two commutators, a variation of 1:4 or more can be obtained, since, by connecting the windings in series or parallel, the speed can be halved or doubled as desired. Also the graduations of speed can be made much finer than by step cones and back gear, so that it is possible to get the correct speed for almost any variety of work put on the machine. It is quite a common thing to have 15 or 20 steps on the regulating switch, and an equivalent number of different speeds. While speaking of this matter, it may be mentioned that machine tools might in many cases be much improved in this respect for ordinary belt driving; the graduations of speed on many lathes, etc., are not satisfactory, and the machine tool makers seem to have paid very little attention to this point in the past, although it is receiving more now.

The possibility of a wide range of speed is, in the author's opinion, a very strong argument in favor of continuous current motors in engineering works as against alternating current motors. With single phase motors, whether synchronous or self-starting induction motors, it is not practicable to vary the speed, since both classes depend more or less on running in step with the generating plant. With two and three-phase motors the same objection exists, though not in the same degree. The speed can be varied by special devices, but the author understands that when running below their normal speed they are very inefficient. He has no actual experience with them, and it will be very interesting probably to most of us if anyone can give further information on this point in the discussion. The author regrets that he has to confess his ignorance on this subject; but, according to President Perry's address, many other engineers are in the same lamentable state. This is not a paper on the relative merits of direct and alternating current supply for motors; but the question of speed variation is one which should not be lost sight of by engineers when debating which system to install in their workshops or shipyards.

Since writing this, the author has read the excellent paper given before the Manchester Section of the Institution, by Mr. H. A. Earle, on the relative advantages of direct and alternating current distribution, which states in a much better and clearer form than has hitherto been published the points for and against each system.

Another advantage of applying separate motors to individual machines is found when it becomes necessary to work overtime in the shops. It may so happen—and often does in the author's experience—that, although the shops in general are not overcrowded with work, a tremendous amount may have accumulated for some particular class or group of machines. It is obviously very uneconomical to run the whole of the shafting, belting, main engines and boilers for the sake of one or two machines till seven or nine o'clock every evening, but yet the work must be got through. One cannot purchase new lathes or boring machines at a few days' notice—in this country, at any rate—nor would it be advisable or profitable to do so, if the large increase in this particular class of work is merely temporary, as is generally the case. But if the works manager be fortunate enough to have these machines electrically driven by their own special motors, his difficulty is solved, for it is possible to work any amount of overtime without serious increase of establishment charges. More fortunate is he still if a supply of energy be available from a storage battery or from the town mains. It is then possible to run night and day by putting a double shift of men on, until the accumulation of work at these machines has been got rid of. It is even possible to take advantage of a double shift on machines which are driven from the main shafting, as a rule, by putting down a temporary motor on the floor to drive the machine at night, while through the day it may be driven either from this motor or from the shafting as before.

Just now, at the works with which the author is connected, there is a large amount of work for which only two or three machines in the shops are well adapted, so two of these have been running night and day for some months past. One is a horizontal boring mill, which is always driven by its own motor; the other is a large face-plate lathe of the ordinary pattern, usually driven by belt from the shafting. At night, the belt is left on the loose pulley of its countershaft, and a belt is slipped on to the fast pulley from a portable motor—with spur reduction gearing attached—which is spiked down to the floor behind the lathe. The starting and regulating switches are temporarily fixed on the front of the lathe headstock, convenient to the man's hand. These machines and the necessary lights are run from the storage battery at present. Probably, before long, the continuous-current supply from the Newcastle Electric Supply Company will be available for this or any other purpose. Again, in the event of an urgent repair or breakdown, work must sometimes go on without intermission, and in such cases it is very convenient to be able to put down a motor at an hour's notice, to run any machine all night. A few weeks ago, a motor at one of the shipyards on the Tyne got accidentally damaged by water or otherwise. The field-magnet coils were brought to the works at 4 p. m. to be rewound, and were 5 p. m. the magnet-winding lathe was belted to a motor and o'clock next morning.

It often happens that contracts are taken for manufacturing machinery of a larger size than any of the regular tools in the shops are capable of dealing with. It is then a case of rigging up special appliances, and carrying them to the castings to be operated on. For instance, some large steel rings for the yokes of multipolar dynamos were far too large for any of the lathes or boring machines to deal with. So a boring bar was made, with standards easily adjustable for height; the magnet-rings were fixed to the slide-rails of the temporarily for the purpose. The work was very satisfactorily performed, which otherwise would have had to be sent testing-bed, and the boring bar driven by a motor, put down to some other engineering works where much larger machine tools were available.

It is now considered much the better plan in works where very large dynamos and alternators are constructed, to employ portable electrically driven tools for slotting, drilling, and planing the large castings necessary. These portable tools are grouped about the casting, and, in many cases, two or more can be operating simultaneously. For instance, one machine may be planing or slotting the face of the half ring, while another is drilling holes through the body for bolting the pole pieces on. Portable tools of this description are employed in practically all the large electrical works at home and abroad. There can be no question that this is the proper method of dealing with large castings.

The question as to whether every machine tool should have its own separate motor, or whether groups of machines should be driven from a line shaft to which one large motor that views on the subject will be expressed to-night. There wanted as early as possible the next morning. Shortly afte. is belted, has been frequently discussed, and it is to be hoped ready for running all night, and the repairs effected by 6 is much to be said for both systems. In the author's opinion no hard and fast rule can be laid down; each case must be dealt with on its merits, as the circumstances vary so much,

especially when converting an old shop to electric driving. As a general rule, it would appear that all large tools demanding, say 2 horsepower and upwards, may very suitably have their own motors. The loss of power in driving long lengths of shafting and belts and countershafting is a very large proportion of the total power developed in most cases. The author is aware that this statement is often rather poohpoohed by mechanical engineers, and said to be exaggerated. But it is a very easy matter to prove our statements. The readiness with which the power used can be measured (when electricity is the motive power) for all the varying conditions under which workshops run is in itself an advantage. In a paper read before the American Society of Mechanical Engineers, Professor Benjamin stated that in six shops taken at random, where heavy machine work was done, an average of 62 per cent of the power produced was used in driving the shafting. In one case the loss was 80 per cent.

The author has made some tests recently, the results of which are given below. A length of 100 feet of 2½ inches diameter shafting, running at 150 revolutions per minute, to which twenty-four machines were belted, took to drive it light, 45 per cent of the power necessary when all the machines were in use. In another case, the power taken to run the shafting and belting on the four floors of a works was 56 per cent of the average power required when the shops were in full swing. The motor used for driving was belted to the center of the shafting on the first floor. On the ground and first floors the shafting is 2½ inches diameter, and a total length of 240 feet, running at about 130 revolutions per minute. To this shafting are belted 71 machines of all classes, the ground floor chiefly lathes and planers, and the first floor light brass-finishing machines chiefly. There is about 100 feet of 2 inch shafting on the second floor, running at 150 revolutions per minute, driving twenty-one machines, chiefly for brass-finishing work and magnet-winding; and a short length of 1½ inch shafting on the third floor. The loss of power in the line shafting and belting is going on continuously during working hours; whereas, with motors to individual tools, whatever loss there may be in the leads, motors, and reduction gearing, is not continuous, for the motors are stopped when the machine is not at work, through changing work, or setting fresh tools, etc. There is thus a further gain in this respect.

With regard to the total horsepower of motors installed, and the average power used, it is in most cases possible to put down a much greater collective horsepower in motors than the power station is capable of supplying, for it seldom happens that the whole of the motors are called upon to develop their full power simultaneously. The ratio seems to vary within pretty wide limits. It is stated that in the Baldwin Locomotive Works only 1,300 horsepower serves about 3,100 horsepower of motors, a ratio of 1:2.4 In the Bullock Electrical Manufacturing Company's Works it is stated that for 127 horsepower of motors and lighting installed, the average load for working hours is only 27 horsepower, a ratio of 1:4.8. This is rather a different case, however, since the lighting is included. Probably a ratio of 1:2 will in most cases be ample allowance for a shop using separate motors to each machine, the amount of power for lighting not being included.

Until electric motors came into use for driving machine tools, very hazy notions seemed to prevail as to how much power a machine of a certain class or size demanded, and those who were least well informed were frequently the makers of the machines. A somewhat striking instance of this may be mentioned. A special form of grinding machine, for trueing up the edges of armour-plates, was put down at some steel works. The manager asked how much power would be required, and the makers told him 6 horsepower. He thought he would be on the safe side, so ordered a motor to develop 10 horsepower. When this was put to work complaints were made to the electrical firm who made the motor that it would not do its work; and as this was their first experience of electrical driving, and they were contemplating putting in a big power plant, they were much perturbed, and did not think electric driving was up to much. The electrical firm was very anxious to reassure them on this point, and the author was sent down to investigate matters. It was found that the motor was supplied with current from a small engine and dynamo of about 25 or 30 horsepower used for lighting, and the grinding machine was demanding more energy than the engine was capable of developing, and practically pulling it up short every few minutes. This was explained and demonstrated to the directors and managers, and permission was given to couple the motor up to a much larger dynamo used for welding. It was then found that the grinding was done in a highly satisfactory manner, but the motor was absorbing nearer 35 or 40 horsepower than the 10 horsepower for which it was built. It continued to do this for some months, occasionally demanding even 60 horsepower—a striking testimony surely to the good qualities of the motor. This result was highly satisfactory to all parties concerned, as there is now a power station with four sets of 200 horsepower each, and a corresponding load of motors for driving machine tools of all classes.

Let us pass on to the various applications of electric power. Traveling cranes are now almost invariably driven by electric motors, and every one agrees that this is an ideal method of applying power to this class of machinery. The question of three-motor versus one-motor cranes has been much discussed. Possibly we shall have further discussion to-night. The balance of opinion seems to be in favor of three-motor cranes, though the one-motor type can be made to work quite as satisfactorily, in spite of what interested parties say. One firm of crane-makers who advocate the three-motor type to the exclusion of the other, built one of their earliest—if not the very first—cranes for a single-motor drive, and their experience with this has apparently been sufficient to change their views utterly. But the fault did not lie in the single-motor drive; it was the bad design and workmanship of the mechanical parts of the work—gearing, clutches, etc.—which caused the whole of the trouble. The author speaks feelingly, as this particular crane was a source of continual worry and trouble for over a year while under his control, until another firm practically rebuilt the crab, remodeled the gearing, etc.

If it be a case of putting in an entirely new crane, probably the three-motor type is advisable; but where an existing crane has to be altered from, say, a square-shaft drive, it is decidedly simpler and more economical to apply a single motor to drive the transverse shaft, and leave all the gearing and clutches as before. The author has had experience with several highly satisfactory examples of this arrangement. Liquid switches are a very convenient form of controlling gear for crane motors.

One or two somewhat interesting applications of motors to cranes have been made at Messrs. J. H. Holmes & Co.'s works. In the machine shop there are three Tangye hand traveling cranes in one bay. Since the time these were put up, the size of dynamos constructed has increased so enormously that it was a very slow business handling the heavy castings now dealt with. It was a somewhat difficult problem how to apply motors to the lifting motion, owing to the limited space between the crane girders, and the absence of head-room. However, a motor was suspended under the girders in a wrought-iron framing bolted to the crab. As this was of necessity somewhat lacking in rigidity, a spur or worm-gear reduction was out of the question. So an ordinary 1-inch pitch bicycle chain gear was used to transmit the power from the motor shaft to the hoisting gear. A stock size of sprocket wheel was screwed on the motor shaft, and a steel disc about 18 inches diameter was cut in the milling machine to fit the chain, and this was fixed to the hoisting spindle.

A 5-ton traveler was first altered in this way, current being supplied to the motor through a flexible cable from a plug and socket on the wall near the works entrance, where most of the loading and unloading is done. It proved so successful, however, that wires were soon stretched along the shop in the usual way, so that the motor could pick up current, and the power lift be used from any position in the shop. A 3-ton crane has also been fitted with the same arrangement. The third crane in the bay has not been so fitted, and it is interesting to see how the shop laborers will always go and fetch one of these power-cranes from the other end of the shop if any heavy stuff has to be lifted, rather than use the hand-crane which happens to be close by. It should be made clear that electric power is only applied to the lifting of these cranes, and not to the travel and the traverse of the crab. The saving of time in lifting heavy weights is enormous. The motors are series wound, so the speed of lift automatically regulates itself according to the load to be lifted.

Another rather novel application of power has been made to a similar 3-ton hand crane on the floor above. It used to be a very slow, laborious job to lift heavy machinery from the ground floor to the first floor through a hatchway, the height of the lift being about 18 feet. So a motor was fixed down permanently on the floor at one end of the hatchway, and a cast-iron pocket wheel to fit the hand hauling chain was keyed to the motor shaft. The motor is fixed in such a position that when the hauling chain has been slipped over the pocket wheel, and the crab moved slightly across the shop to tighten the chain sufficiently, the crane hook is in the center of the hatchway. By this means a load can be lifted from the ground floor in about two minutes, which formerly used to take four men about half an hour to do. Of course, in this instance the power lift is only applicable at this particular spot; but, to enable loads to be moved about the shop, it is usually only necessary to raise them a few inches from the floor, which is not a long operation by hand. A similar arrangement has been fitted to a crane on the second floor also.

One very neat method of applying motors to machines is to suspend the motor on a hinged frame attached to the joists under the floor, and drive by a belt coming up through the floor. The weight of the motor keeps a tension on the belt, and, of course, with a large motor it must be partially counterbalanced to prevent too great a tension. Several machines in the pattern shop at Messrs. J. H. H. & Co.'s are driven in this manner, there being a basement below the shop. Circular saws and band saws are so driven, and a great deal of floor space is thus saved.

There is a somewhat novel application of a motor in the pattern shop. It was necessary to provide a much larger lathe for turning up big magnet-ring patterns and similar things, and, as there was a five-horsepower slow-speed motor available—the normal speed being 150 revolutions per minute—it was mounted on a cast-iron stool, and a disc flywheel attached to the armature shaft direct, to form a chuck or face-plate, to which work could be fixed in the usual way. Proper provision was made, of course, for taking up all end-play of the armature. Some dynamo slide rails were bolted to the floor in front of the motor, and a cast-iron pillar to support the **T**-rest can be moved in any direction on these rails to suit the work. This novel lathe will swing work up to about seven feet diameter, and has proved very successful. The speed can be varied from 150 to 600 revolutions per minute by shunt-resistance. An ordinary lathe to swing this diameter of work would have been an expensive matter. Also, it was possible to fix this close against the wall, thus taking up much less space than a lathe would occupy.

A radial drilling machine for drilling and tapping up to 2 inch diameter holes is driven by a two horsepower motor, the gearing being a Hans Renold silent driving chain. The motor is mounted on the cast-iron box containing the gear wheels of the machine at the back of the pillar, the distance between centers of motor and machine shafts being only about two feet. The starting and speed regulating switches are mounted on the pillar, close to the man's hand.

While speaking of drilling machines, mention should be made of the application of electric motors and flexible shafts. The motors are usually mounted with their reduction gear complete on wheels, so that they can be readily run about from one place to another. The "Stow" flexible shafts are usually about eight feet long, and are coupled to the motor shaft by a universal joint coupling. The shaft may be curved and bent in any direction, and with a suitable drill press, holes up to 2 inches diameter can be drilled with a 1½ horsepower motor. The convenience of these outfits in shipbuilding, bridge, and building construction can only be realized after they have been employed. The current is conveyed to the motors by an armored flexible cable, which may be of any length required. Smaller motors and flexible shafts for use with a breast drill press, for holes up to ⅜ inch diameter, are also largely used. In many cases a self-fixing magnetic drill post can be used with advantage in place of the ordinary "swan-neck." These magnetic pillars or posts hold on with an astonishing force. The author tested one in drilling a hole 1½ inches diameter in cast iron, the magnet only taking rather less than 1 ampere at 120 volts. The weight of the post was about 50 lbs., and it required a direct pull of 16 cwt. to detach it from a rough machined steel surface.

Another very neat portable drilling tool was brought out a year or two ago by one of the leading electrical firms in the country, for drilling small holes rapidly in the thin deck plating of torpedo boats. This motor and reduction gear is enclosed in a metal case, with the drill projecting at the bottom. There are two handles, one at each side, on which the workman presses when drilling, and by which the machine is carried from point to point. It only weighs about 60 lbs., if the author remembers rightly. A test, made in one of the shipyards on the Clyde, proved that about 600 holes, 3/16 inch diameter, could be drilled through a plate ⅛ inch thick in one hour.

Perhaps driving a planing machine with a separate motor is about the most severe work to which a motor can be put, as the load at the moment of reversal with a great weight on the table runs up to three or more times the normal current. If a motor drives the planer by open and crossed belts, and runs continuously in the same direction, a heavy flywheel on the motor shaft is of great assistance in helping it over this sudden strain. In one case with which the author had to do, a very large vertical and horizontal planer—or wall planer, as it is sometimes called—was driven by a compound-wound motor, with the series helping the shunt, and thus the considerably higher speed at which the motor runs at light load was of advantage in the return or non-cutting stroke.

Another case of power being under-estimated by the machine tool makers was in the case of a slab milling machine for milling surfaces up to 18 inches or 20 inches wide. For a specified depth of cut and rate of feed they estimated it would require 6 horsepower to drive it, whereas it was found that the power absorbed was nearer 15 horsepower. Two motors were applied to this milling machine eventually, one to drive the cutter, and the other—a smaller one—to drive the feed motion and table. In both cases the speed could be varied within very wide limits by means of resistance in the shunts. The feed and speed being entirely independent, was found of great advantage in this case. A comparison was made between a slab milling machine, using a fluted spiral cutter of the ordinary pattern for heavy work, and a machine which was really a cold sawing machine, but which was fitted with a milling or facing head, having inserted tools or cutters. It is interesting to note that the latter class of milling only absorbs about one-half the power for a given weight of

material removed in a given time. This is due to the fact that the cuttings are much larger and thicker, similar to the cut of a lathe or planer, while the ordinary milling cutter removes the metal in very much finer particles.

Horizontal boring and drilling machines can very suitably have the motor mounted on the rising and falling head or saddle of the machine, and geared direct by spur gearing. A machine of this class has been so fitted recently. It was formerly driven from the main shafting and a countershaft. A jockey pulley and weight arrangement was necessary to keep tension on the driving belt, for, when the saddle of the machine was raised or lowered to suit the work, the length of the belt varied greatly, the drive being at an angle of about 60 degrees. The application of the motor has dispensed with this unsightly arrangement, and has enabled the machine to be moved to a more convenient position at the opposite side of the bay.

It is sometimes more convenient for lifting work on and off certain classes of machines—say, horizontal lathes and radial drills—if they are fixed at right angles to the walls or columns. This is not usually very practicable with belt driven from the shafting, but can be readily arranged when driven by separate motor. A boring mill was arranged in this manner recently, the countershaft being supported at one end by a hanger bearing under the traveling crane gantry and at the other end by a pedestal bearing fixed on the top of the boring mill. The motor was fixed on an angle bracket bolted to the side of the machine, and is belted to the countershaft by a short belt. The switches are arranged at the opposite side of the machine, near the feed handles, etc.

In the case of very large and comparatively slow running lathes and boring mills, a motor is sometimes coupled direct to one of the cone pulleys of the machine, and mounted on a bracket on the wall, to drive down to the cone pulley of the machine. Or, if a motor with very large range of speed be used, it is coupled direct to the lathe gearing, and so dispenses with the cone pulleys and belt altogether. Some very large lathes for ordnance work had hinged frames attached at the back of the headstock. A cone pulley corresponding to the lathe cone was fitted on the motor shaft, and the motor mounted on the hinged frame. The weight of the motor then kept the requisite tension on the belt, as it tended to fall away outwards from the headstock. A very short belt was sufficient, and the arrangement took up very little space. In connection with one of these large lathes, when first fitted with a motor the workman in charge was very sceptical about how much work he could turn out of his lathe. He asked how big a cut he might put on without pulling it up, and was told to put on all he could. He was turning a heavy gun forging of about 30 tons, and there were two saddles on the lathe with four tools in each. When he got them all taking their full cut he was very much astonished that it apparently made not the slightest difference to the motor, which, of course, ran as quietly and practically at the same speed as before. He was genuinely converted to electric driving.

A very convenient little tool can be made by mounting a small motor, say ¼ horsepower, on a square steel bar, and attaching an emery wheel direct to the armature spindle. If any lathe centers have to be trued up, this apparatus can be bolted on the tool post of the saddle, and readily used to grind up the live center.

Nothing has been said about the relative merits of various forms of gearing, as this seems rather outside the scope of an electrical paper. The question as to which is best suited for a particular purpose depends largely on the circumstances of each case; but direct-coupling, belting, pitch chains, Hans Renold chains, spur worm and friction gearing, have all been used with very satisfactory results in electrically-driven machine tools. The author may mention that a most interesting friction gear for reducing speed has recently been brought out by a gentleman named Brown, and is called the "Twentieth Century Gear." It seems to have some excellent points for use in connection with small high-speed motors, though no figures are available yet as to its wearing qualities. It is an internal rim friction device with three rollers, two of which revolve on fixed spindles, while the other is free to change its position somewhat according to the torque. The low-speed friction-driven rim or pulley is concentric with the motor spindle, and takes up no more space than an ordinary pulley would do. The efficiency seems to be remarkably high. Worm gearing is often employed where a very large reduction of speed is necessary, and in cases where it is important that motion cannot be transmitted in the opposite direction, for instance, in hoisting motions of cranes, where the load will be self-sustaining, with a single or double-threaded worm. Worm gear is somewhat expensive to make. Spur gearing is largely employed, and cut gears are used in nearly all cases for high-speed work. The use of raw-hide pinions has proved of great advantage in motor reduction gearing, and runs very quietly. Chain gearing is very suitable in many cases where the drive is short, though too great or not rigidly enough fixed to enable spur gearing to be used. It is generally less noisy than spur gearing, and has the advantage of positive drive, which belting has not. Direct-coupled motors are useful for machinery which runs at a high speed, such as fans, blowers, grinding machinery, etc. For slow-speed machinery they become very heavy, and, of course, more costly, and rather less efficient; though the absence of noise and wear and tear of gearing, etc., compensates for these points in many cases.

In conclusion, it is not necessary to dwell upon the advantages of electric power transmission in general, over shafting and gearing in factories—these are becoming fully recognized in all branches of manufacture, and the reasons are not difficult to find. In nearly all cases works grow in size, and are extended and added to bit by bit. A new pattern shop, new foundry, or a shop for any special purpose may be built quite apart and any distance from the main building. It is hardly necessary to state how much easier it is to provide these detached shops with power by means of a couple of wires and a motor, than in the old method of erecting a long line of steam piping or line of shafting, involving perhaps the use of bevel gearing or half-twist belts, to say nothing of the difference in efficiency. If works were put down at the outset for the maximum output they were ever to attain, some of these advantages of electric driving would disappear; but is this ever the case in business? A works must grow, like everything else, in the natural course of things.

Everyone engaged in the trade—or shall we say, "profession?"—of electrical engineering is anxious to see the use of motors extended, and if this short paper prove of some slight assistance towards that desirable end, by directing attention to their application to this special class of work, the author will not have occupied your time in vain.

AN EXPOSITION OF SAFETY DEVICES.

The American Institute of Social Service will hold in New York City, in January next, an exposition of devices for safeguarding the lives and limbs of working men and women, and for preventing accidents under the ordinary conditions of life and labor to which the general public is exposed.

This will be the first exposition of the kind in this country, and it is surprising to note how far behind other nations we are in this respect.

As far back as 1889 there was a German Exposition for the prevention of accidents. In 1893 an exposition of this nature was held in Amsterdam, and since then there have been several similar expositions in continental Europe and in Canada.

Boise, Idaho.—The Boise and Interurban Railway Company are at work on the cutoff by which the line is to be connected with the Oregon Short Line.

IN HOW SMALL A TOWN IS IT POSSIBLE TO SUCCESSFULLY OPERATE AN ELECTRIC LIGHTING PLANT?*

By R. B. Forster.

Some time ago our honorary secretary asked me if I would read you a paper to-night, when I informed him that my time was so taken up that I could only prepare a short one. He replied, "The shorter the better; it will leave more time for the discussion." So if I have defrauded you in any way by the shortness of this paper, it is (to use an American expression) "up to you" and our honorary secretary to add the missing sheets in the form of a lengthy discussion.

About two years ago I heard a gentleman state at one of our meetings in this room "that it was not possible to operate an electric lighting plant successfully in a town of less than 5,000 inhabitants." I do not, however, intend to bring forward a series of arguments against this statement; it will, I think, be more to the point if I describe to you a small plant which has been for some time, and is at present, successfully operated in a town of 800 inhabitants, in competition with a gas company. The plant referred to is that of the village of Western Springs, Illinois (about seventeen miles west of Chicago). There are plants successfully operated in American towns smaller than this, but as I have no authentic information regarding them I must confine my remarks to this particular one.

The conditions under which it is worked are by no means ideal, as the power house is situated some distance from the railroad. This, of course, necessitates hauling all the coal, and, owing to the high price paid for labor, it adds considerably to the cost of the fuel. There are three horizontal tubular boilers—one 6 feet by 12 feet and two 4 feet 6 inches by 12 feet. The large one is worked at a pressure of 100 pounds to the square inch, and the two smaller ones at a pressure of 80 pounds to the square inch, only the large one or the two smaller ones being worked at the same time. The engine is a 100 horsepower simple "Ideal" with piston valves, and runs at 300 revolutions per minute. It is belt-coupled to a 1,000 volt, 60 kilowatt, two-phase S.K.C. dynamo; the field current being supplied by a 1¼ kilowatt exciter driven by a belt off the dynamo shaft. Mounted on the dynamo are two adjustable rheostats, one in each phase. From the dynamo the two phases are brought separately to a high-tension switchboard, where they are connected through two double-hole switches to two sets of mains. The switchboard is very simple, and consists of only two double-pole double-fused switches, two S.K.C. ammeters, one S.K.C. voltmeter and one S.K.C. ground detector for test purposes.

The outside work is carried out on the usual American plan— viz., overhead bare conductors strung on wooden poles. There are, as already stated, two pairs of mains, one pair connected to each phase of the dynamo. One pair is used for private lighting, and the other for street-lighting, the line voltage in each case being transformed from 1,000 volts to 110 volts by means of transformers fixed on the poles. On the street-lighting mains there are 100 32 candle power lamps and six Jandus arc lamps. In nearly all cases the lamps are suspended over the middle of the street. This is accomplished by putting a wooden pole on each side of the street (or in the case of a crossing, at opposite corners, and stringing two parallel wires from one to the other, which act as suspension wires for the lamp. There is also a means for sliding the lamps up to one pole for renewals and repairs. This system not only gets rid of the shadow difficulty, but it also throws the greatest possible amount of light on the street, for in the case of lights placed on the side of a thoroughfare practically half the illumination goes to waste.

For private lighting, two insulation-covered wires are strung from the secondary of a transformer to the attic of the house, where they are brought through the wall in two porcelain tubes to the main switch. The methods of wiring the houses usually adopted are "cleat wiring," or "concealed wiring by means of porcelain tubes." Cleat wiring, although not much used in this country, makes a very good job if properly installed. The chief objection to it is its supposed unsightly appearance. This, however, is reduced to a minimum if the first and last pairs of cleats are put in first; then pull the wires tight; and, lastly, put in the intermediate cleats. By this means all the cleats are brought into line. When a finished building is to be wired, either this system or wood casing ought to be used. Cleat wiring, has, however, the advantages of being more accessible and being very much cheaper, and as the wires are exposed there is less heating. Where the cleats are not seen, wire nails with leather washers may be used in place of screws. When the installation is to be carried out in a building during construction, the joists are bored with a corner brace, porcelain tubes are slipped in, and the wires are strung through these, tappings being taken off for the lights and switches. Usually the lamp socket switch is used; this, of course, obviates a good deal of wiring. The tappings are brought down to the light through two porcelain tubes placed in a piece of bridging. If a separate switch is required, tappings are taken off the main wires and brought along two adjacent joists by means of single-wire cleats, and thence to the switch. These cleats are usually made by breaking in two an ordinary two-wire cleat. In this system the wires can be kept a good distance apart throughout their entire length, and only coming in contact with the porcelain tubes, the insulation resistance is as perfect as possible. In addition to being a good job electrically, it is good mechanically, as with ordinary care it is almost impossible for wires of opposite polarity to touch. It has another advantage—namely, cheapness.

The load on the street mains is 13½ amperes all the year round. On the private lighting mains there are 80 consumers, which give a summer load of about 12 amperes and a winter load of 15 amperes. In summer the engine is run for about seven hours per day, and in winter about twelve hours per day.

In addition to the electric lighting plant, there are two direct connected Blake pumping engines for pumping water from the springs in the vicinity to the water tower which supplies the village with water. Each pump is capable of delivering 35,400 gallons of water to the tower per hour, but as only 177,000 gallons are required per day, it is only necessary to run one pump for five hours per day.

As regards the working expenses and receipts I found it very difficult to obtain figures, but I have it on good authority that for the last year the total expenses were $6,000 and the total receipts $6,746. This only shows a profit of $746, but it must be taken into consideration that the plant supplied light to the village as well. The price charged to the consumers was 10 cents per kilowatt hour.

In operating a plant in a town of this size, the most important considerations are to produce the current cheaply, to distribute it cheaply, and for the consumer to be able to use it cheaply. One of the chief drawbacks to the use of electric light in private houses is the cost of installation, and if we had a cheaper method of wiring them we would find electricity more universally used for illuminating purposes.

* Paper read before the Great Britain Institution of Electrical Engineers.

San Francisco, Cal.—Devisadero street will soon be brilliantly lighted with new ornamental lamp posts carrying triple globes, which will be installed six to a block. The street improvement association has already succeeded in raising one-half of the $7,500 which it is estimated will be required to defray the expense of installing the new electric lighting scheme. The members of the association hope to secure the co-operation and assistance of the municipal authorities to make the desired improvements and also count on the aid of the San Francisco Gas and Electric Company.

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EDITORIAL.

THE REGULATION OF SPEED AND VOLTAGE IN WATER POWER ELECTRIC PLANTS.

Of greatest importance in any water power plant is a sufficient supply of water at all seasons of the year; next, in the series of requirements is efficient water wheels or turbines at all loads, and, undoubtedly next come proper regulating devices which will produce practically a constant speed even when the output is suddenly varied through a range equal to the full normal rating of the wheel.

Independent of the demand for power, change in the speed of the alternating current generators in any water power plant effects every motor of whatever kind on the system. Continuously constant speed is often necessary for the successful operation of many manufacturing establishments, and more than large variations in the voltage, sudden changes of speed must be prevented in the design of the system.

It is commonly understood that close speed control is much more easily obtained with the use of high head impulse wheels than when low head turbines are operated. Mechanically this is evident since relatively the amount of water to be handled in high head installations is many times less for the same power than with what are usually termed low head stations. In many cases where high heads are used the control of speed is entirely accomplished without changing the flow of water or decreasing or increasing its velocity. In such cases a fixed quantity of flow is at all times passing through the wheels, the increase or decrease of the electrical power output being met by deflecting the stream on or off of the wheel buckets. This method of speed control accomplishes the desired result in practically constant speed at all loads, most effectively, and in the shortest possible time, but is not economical in the efficient use of water. In many cases, when the water after discharge from the wheels is again utilized for other plants or for water supply for irrigation or domestic use, it is necessary at all times and at all loads on the plant, to allow a constant flow, in which case the deflecting nozzle or deflected stream of water is the best method of constant speed control.

For impulse wheels deflecting loads are also readily operated to keep a constant speed. In this method the stream of water is deflected or cut off from the buckets of the wheel, but the quantity of water delivered and used by the station is not changed in proportion to the change of load.

The introduction of the needle nozzle was a decided step in advance toward the saving of water at light loads. Hand regulation of the needle nozzle and automatic control of a second ordinary deflecting nozzle, both nozzles being in use on one wheel, gives excellent and efficient results. An automatic control for both a needle and a constant area nozzle may also be readily devised and will many times give the best results in the economical use of water and the constant speed of the unit. When a sudden change in the velocity of the water in the pipe line has no serious results, the automatic control may be applied solely to the needle nozzle, the most practical and effective method of varying the amount of water delivered to the wheel by varying the effective area of the nozzle opening.

For turbines or other low head wheels the only practicable method is to automatically vary the gate opening and thereby change the amount of water used. To produce the required changes in the short interval allowable in good speed control is very difficult in cases of sudden large variations in the load. Water wheel governors for such turbines have developed into large machines in themselves, but their effectiveness has correspondingly increased.

While not in all details directly connected with the control of the speed, the regulation of the voltage so as to make it as nearly constant as may be at the center of distribution, is of much importance. In making this most desirable result possible too much credit cannot be accorded to what is known as the Tirril regulator. Although a somewhat complex mechanism, its operation is quite simple, and the results accomplished by its use are most satisfactory.

BOOK REVIEWS.

"Chicago, The Electric City," is issued monthly by the Electric City Publishing Company, of Chicago. The object of the publication is stated "to help make Chicago the greatest electric city in the world." The illustrations showing the methods of electrical illumination in use in the various buildings of Chicago are particularly fine. The paper is most interesting to those seeking information regarding electrical illumination in general.

"Get Out Or Get In Line" is the subject of a recent clever publication issued by A. L. Ide & Sons, engine manu-

facturers, of Springfield, Ill. The advice contained in the "Preachment," which is from the pen of Elbert Hubbard, is excellent, and applies to engineers as well as to others seeking success in any field.

The 1906 edition of the "Handbook," on "Bare and Insulated Wires and Cables," compiled by Joseph W. Marsh, and published by the Standard Underground Cable Company of Pittsburg, has recently been issued. The last edition of this "Handbook," which was No. XV, was published eight years ago, and the new edition, while containing much of the useful data and information of the earlier issues, has been entirely revised and rewritten, and much new material introduced.

The book is divided into six general divisions.

First: Price lists of insulated wire cable and accessories.

Second: General telegraph code in which is included a blank private telegraph code which can be utilized by each particular possessor of the book.

Third: Descriptions of the products of the Standard Underground Cable Co.

Fourth: Working descriptions for placing, splicing and connecting cables.

Fifth: Testing of cables and the location of faults, etc., and

Sixth: General and electrical information.

The "Handbook" complete has been very well edited, and will be found exceedingly useful to engineers and others interested in the electrical business.

Copies of the "Handbook" may be obtained from the home office of the Standard Underground Cable Co., at Pittsburg, Pa., for the following prices:

Grade A, bound in blue cloth $0.50
Grade B, bound in plain leather, gilt edges 75
Grade C, bound in limp leather, bill flaps, pockets and gilt edges 1.00

CORRECTIONS AND ADDITIONS TO PROGRAMME.

Author of Paper Four . . . . . E. C. Jones
Author of Paper Seven . . . . . F. A. Leach, Jr.
Author of Paper Six . . . . . C. E. Moore

THE LARGEST GASHOLDER IN THE WORLD.

Up till now England has held the record in the matter of gasholders of large capacity, with the 12,000,000 cubic feet holder of the South Metropolitan Gas Company at East Greenwich. But now New York takes the lead in this respect, with a 15,000,000 cubic feet holder being erected for the Astoria Light, Heat and Power Company. The diameter of the holder is 300 feet (the same as that of the East Greenwich structure), but the tank is 48 feet 6 inches deep, as against 30 feet at East Greenwich. The holder, when fully inflated, stands 260 feet high. This holder is the first of a series of six of the same capacity that have been planned for the Astoria Company, whose manufacturing plant, when completed, will be capable of producing 240,000,000 cubic feet of gas per day. At present the daily demand of Greater New York amounts to about 123,000,000 cubic feet, and superimposed upon this is a daily demand of 70,000,000 cubic feet from Manhattan Island and The Bronx.

Trade Catalogues.

The Central Electric Company of Chicago are sending out to the trade their August price list applying to their general catalogue No. 24. The prices quoted are the very latest in force, and it is suggested that any one who has been overlooked in the distribution write the Central Electric Company for a copy.

Bulletin No. 609, of the Stanley-GI. Electric Manufacturing Company, is devoted to their water tight adjustable outlet boxes for connection of cables for electric lighting, heating, etc., in floors, baseboards, walls, etc. These boxes are made both square and oblong, of drawn steel, and are a great improvement over similar boxes with joints or seams.

Circular No. 786, of the same company, is devoted to a description of the enclosed direct current arc lamps of the Stanley-G. I. type. Circular No. 787 gives details of their direct current motors and generators, including motors for direct connection to machine tools, etc.

"The Progress and Logical Design of Reinforced Concrete," is the title of Bulletin No. 12, recently issued by the Association of American Portland Cement Manufacturers. It is a paper by Mr. Ross F. Tucker, M. AM. Soc. C. E., the well-known concrete steel engineer, President of the Tucker and Vinton Corporation, New York City, and was read at the June meeting of the association at Atlantic City.

It is interesting to note that the first reinforced concrete buildings in the country were designed and engineered in and around San Francisco by Ernest L. Ransome, the pioneer in construction of this character. A number of cuts of these buildings are given, showing how well they withstood the recent earthquake and fire.

Copies may be obtained by addressing C. Earle E. Bottomly, assistant secretary, 1232 Land Title Building, Philadelphia.

The Paraffine Paint Co. of San Francisco, who manufacture the Malthoid roofing, have issued a souvenir of the great San Francisco fire. It is a very attractive little pamphlet containing cuts of the ruins of many of the old familiar buildings and streets, together with a number of the temporary structures in Golden Gate Park, in the Presidio and throughout the city.

The advantages and many uses of Malthoid as a building material are well brought out.

A little booklet by A. Frederick Collins on "How to Make an Experimental Wireless Telegraph Outfit," gives full and detailed instructions for making at home, at little expense, a practical wireless telegraph outfit.

A set constructed as described will fulfill all the requirements of the laboratory, and if so desired, it may be used to telegraph over water a distance of a quarter of a mile or so.

Published by W. L. Hedenberg Publishing Co., 136 Liberty street, New York.

The Gould Storage Battery Co. of New York have issued two new catalogues pertaining to their stationary type of batteries.

Catalogue H, part 1, contains information relative to these types in glass and rubber jars.

Catalogue I, part 2, relates to the same type in glass and lead lined tanks.

Engineering Sheet No. 6, issued by the Locke Insulator Manufacturing Co., Victor, N. Y., gives some very useful information in regard to the wet or precipitation test of insulators.

ECONOMIC AND FINANCIAL PHASES OF INTERURBAN RAILWAYS.*

GUY MORRISON WALKER.

By your attendance at this school you have indicated your choice of a profession, and as engineers you will find yourselves chiefly interested in the so-called public utilities or necessities which include those things of almost universal use, without which the public can hardly get along. In this field you will find yourselves concerned with the railroads that carry our commerce; the street car lines that have made possible the growth of our cities; the water systems, whose supplies have kept from them decimating epidemics and devastating fires; with telephone and telegraph lines, which have made time and distance of no consideration; with gas and electric light systems, which have added to our comfort and safety; with heat and power companies, or some one of the new utilities that science is constantly adding to our already long list of necessities.

Your choice of a profession made, the next problem that will confront you will be the selection of a specialty. In the selection of a specialty one of the first things to be considered is the extent to which the utility you choose is used by the public, for upon this feature of your specialty will largely depend the stability and permanency of your occupation. Should you select one of those utilities, the use of which by the public is small, and the amount of new construction comparatively limited, you will find yourselves facing frequent periods of idleness, while the infrequency of new work in that line will make employment hard to find. If, on the other hand, you select for your specialty a utility of which the public must necessarily make large use, you will find yourselves in a field in which progress is steady and business and construction not only continuous, but growing in volume. Here you will find not only steady employment, but many opportunities for advancement.

It was the result of an investigation along these lines that turned me from the active practice of law into the specialty that I have since followed, for I found upon investigation, that while the mass of people paid about a dollar and a half per capita for the use of telephones, they paid two dollars and a half per capita for the use of electric light; for the use of gas they paid as high as three dollars and a half apiece, but they paid eight dollars and a half apiece to the electric railroads that took them to and from their business, while to the steam railroads which brought them their food and clothes and the raw material upon which they worked, and which carried away the products of their labor, they paid over twenty dollars apiece. When you realize the meaning of these figures you will see the place that transportation holds in the life and development of the country. You will find that the development of transportation facilities is at the very foundation of all material progress; that commerce and industry wait upon them and that prosperity and the increase of wealth halt and mark time when their advance ceases. You will find that there is a definite, fixed relation between wages and the facilities and cost of transportation; that in the absence of transportation facilities and in the presence of a high cost or rate of transportation, industry languishes, labor finds little to do and wages remain low. While as transportation facilities increase and transportation rates grow lower and cheaper industry thrives, markets widen, commerce grows and wages increase by leaps and bounds.

When you see that all our great wealth is beholden to our transportation facilities and that all industry and commerce is forced to pay tribute to them, you will realize that the support of our railroads is insured by a tax upon the whole people, a tax more impossible to escape than that imposed by cities and states, because the laws by which they are levied and collected are natural instead of human. With this view of the dependence of all other lines of business upon the business of transportation, you will understand why its problems are so fascinating and its rewards so great, and why as a business it has engaged the attention of so many of our brightest minds. Even a cursory survey of the field of endeavor should satisfy you that the business of transportation is the greatest to which you can devote yourselves, and that in it you can find the widest field for the exercise of your talents as engineers.

We have reached the stage in our national life where further development of our country, and in order to insure its continued growth in produce and wealth, requires the construction of interurban electric railways to supplement the splendid service rendered by our steam railroads. It is not economical for a locomotive, built to haul a train of cars, to waste its power in moving a single car, while the system of electric traction is arranged to move single cars, whether passenger or freight, with the greatest economy and dispatch. It is this which makes it possible for them to make the numerous stops and furnish the frequent service which are impossible to the steam railroad, and which indicate that the province of the interurban electric railway is to relieve the steam railroads from their local or short haul passenger traffic and to gather at convenient transfer points carload lots of freight for their further transportation in trains.

As a rule, all lands desirably located and within a reaching distance of these interurban lines have doubled in value, and increases of fifty to one hundred dollars per acre in the selling price of farms along such lines are common, even when the distance from the city is as great as twenty miles. In fact, wherever these interurban roads have been built, there can hardly be said to be any country at all, but that the whole region has become transformed into a great though scattering city.

It should, however, hardly be necessary at this late day to make any extended argument to prove the advantages and necessity of interurban railways, and so it is rather to the problem of their future development and to the shortcomings in their management that I wish to call your attention.

The operation of steam railroads extending over a period of more than 70 years, has been reduced to almost a science, but the development of electric roads has been so recent and so rapid, and the improvement of electrical equipment and motive power so continuous that satisfactory data from which to study the operation of electric lines has been hard to obtain. Then, too, there has been a sad lack of competent management, and the supreme need of electric railways today is intelligent and economical operators. The extravagant and wasteful operation that most electric lines have survived would have wrecked all but the best of steam railroads.

It is this condition in connection with interurban railways that makes the field so promising for young men, for it is comparatively easy to succeed a prodigal operator in the management of a property and make a fine reputation for yourselves by the economies that you can easily effect.

In the construction of railways there is a constant conflict between two diametrically opposing views. First, there is the view of the engineer whose scientific and technical education leads him to plan and urge the best that money can buy or produce; regarding the proposition as an opportunity to show his engineering skill. He struggles for long tangents, low grades, heavy bridges, wide cuts and fills, and a surplus of motive power, constantly holding up to view the desirability of securing economy of operation and low cost of maintenance. On the other hand stands the promoter or broker, who, ignoring all these physical problems, tries to see how much paper in the shape of bonds and stocks he can issue and float against the least possible real property.

A story related of the late Senator Brice is appropriate because it particularly illustrates these divergent points of view. It is related that on one occasion the Senator called upon his engineers for plans and specifications for a proposed

* Abstract of address to the students of Sibley College, Cornell University.

road. When the plans were completed and handed to him he sat down to look them over. After he had completed his examination of them he sent for his chief engineer and upon the latter's appearance the Senator turned upon him and indignantly demanded, "What do you think this road is being built for?" to which the engineer replied, "Why, to carry passengers and freight, of course." The Senator retorted, "Well, it isn't! It is being built to carry bonds."

Now, the fact is that neither point of view is the correct one, but that somewhere between these two extremes lies the true economic means of a road good enough to carry the traffic and business in its territory, with enough stocks and bonds issued against it to recoup the bankers and investors for their outlay. The motto of the engineer that "The best is none too good" is all right so long as it refers to the quality of material and work, but the attempt to follow this motto to the limit has led to many economic crimes. Our first electric railways were built in the cities where heavy traffic called for heavy construction and after being built the maintenance charges were high, but these were easily supported and taken care of by the high earning power per mile of track among city populations.

The first engineers on interurban railways came from these city lines, and with their city experience they imposed upon these interurban roads city construction and supplied them with city power, as if for city traffic, burdening them not only with a heavy fixed charge to cover the abnormal capital expenditure, but with the expense of a general organization like that on city lines. One of the first interurban roads that I ever saw was fifteen miles, laid with ninety-pound girder rail along the side of a public highway, and this was not changed until the road had been compelled to pay some fifteen death claims growing out of this foolish construction. Another road that I knew of, with less than twenty miles of track, had a president, a general manager, a superintendent, a chief engineer, an assistant engineer, a chief electrician, an assistant electrician, a treasurer, an auditor, a traffic manager, a claim agent and a road master; all these to look after the business developed by three cars furnishing an hourly service in each direction over the road.

It was only the fact that these interurban roads were built in thickly populated communities that enabled most of them to carry this burden and survive the management that they endured. Few of them proved profitable until, as years rolled on, the farms through which they ran were cut up into small plots, the communities filled up with new population, and the traffic developed to the point where it was able to absorb this early waste.

When interurban railways first began to be built, there were many places where the population was already so dense and well distributed as to furnish the traffic necessary to make such roads pay, but the ten short years that have elapsed since interurban electric railways were first proved to be successful, have sufficed to see almost every locality with traffic and population enough to support an interurban railway, already supplied with such a service. Indeed, reckless promoters and ignorant investors have built many such lines in communities not yet sufficiently developed to support them, and now find that they have an investment which not only yields them no income, but that the traffic in many instances does not yield enough to pay even operating expenses, and so they are threatened with the loss of their principal, and the fault in many of these cases has been due to the short-sightedness and stupidity of the engineers in charge of the construction.

There is a strong disposition on the part of most engineers to spend on the construction of a road all the money that they can get their backers or clients to put up. As an illustration of this I can cite the case of a small road only seventeen miles in length running from a city with 150,000 population to a city of about 10,000, the smaller city also having an excellent lake resort. The gentlemen backing the enterprise were bankers and conservative business men of large means who solemnly determine that in the case of their road there should be none of that waste and expense incurred by penniless promoters who have to resort to all sorts of plans to finance their schemes. These worthy men knew that some of their friends had made a large amount of money in interurban railroads, and they decided to go into the business for themselves, but as none of them were railroad men, they determined to get what they believed to be the best expert advice obtainable on the subject, and so employed one of the leading firms of electric railroad engineers in the country. They had heard that a good interurban railway could be built and equipped for an aggregate sum of twenty-five thousand dollars a mile, and they explained to the engineers that the smaller city before mentioned, was about half way between the larger city and the terminus of another road, and that they desired also to build this link of 39 or 40 miles, and that they had raised among themselves a fund of one million dollars. They explained to these engineers that they desired a good road and that with cash on hand they wished the benefit of every economy that could be secured by paying cash for everything, but that, as they were without railroad experience, they should depend upon and be guided by the advice of these engineers.

At the time that I was called upon to investigate the situation the engineers had completed the 17 miles of road from the large city to the small one, leaving 22 miles yet to build in order to reach the terminus of the other road. The construction work so far as it had gone, was excellent. The road had been built in perfect line and absolutely without grade except for an undergrade crossing of a steam railroad. It was laid with 80-pound steel rail on cedar ties, laid three thousand to the mile, with three feet of crushed stone ballast under the ties. The poles were trimmed octagonally, heavily painted, and set in concrete bases and so perfect was the alignment of the poles and overhead brackets that the last pole and the last bracket shut out from sight all others. The cars were splendid Pullman coaches 56 feet in length over all, equipped with four 75-horsepower motors and weighing almost forty tons apiece. The power house was a magnificent structure containing excellent general offices, and built to hold two complete units, each of which was designed to operate the entire 40 miles of road, though only one unit had been installed. The whole property was altogether the finest and most perfect of interurban railroad construction completed in this country up to that time.

But the trouble was that at this point the bankers who had been footing the bills found that the entire million dollars that they had raised had been expended, and as their funds were exhausted, construction work was forced to stop, even though they had less than half as much road as they had expected. The property, however, that had been built, was a monument of engineering skill, and the engineering firm which built it took such pride in it that they made a practice of taking prospective clients out to see this road as an exhibit of the kind of work that they did. Now persons contemplating the construction of such roads usually make it a point to see and have an interview with the owners of such a property and the gentlemen owning this road which had cost them so much more than they had expected it to cost, had no choice but to begin operating the mileage already built while looking for a way out of their trouble. The first year of operation the road took in $40,000 gross, every dollar of which was eaten up in operation, so that their loss for the year amounted to $50,000, or the interest on the million dollars that they had invested. With no net earnings it was impossible for them to sell their bonds. Their capital was tied up, and although every man in this group was active, they were unable to consider any new enterprise. The second year of operation produced $49,000 gross earnings, while the cost of operation was reduced to $38,000, making net earnings of $11,000 or a little over one per cent on their

investment. But the third year they induced some friends to join them in building the link of 22 miles necessary to connect their property with the other railroad. The construction of this link brought to their road the business of a city of 300,000, and nearly doubled the traffic and receipts of their first mileage, yet it was not until the fifth year, after a consolidation of their original mileage with the newly built link, that they were able to sell $800,000 of bonds on their property and so get back some of their capital that had been tied up for so long.

As a consequence of the experience of these gentlemen, the engineers who built the road sustained a long series of disappointments, for as a rule the prospective clients, after having seen the owners of this wonderful property, went on their way with the joy of men who have narrowly escaped a great catastrophe, while to this day the mere mention that this distinguished firm of engineers has anything to do with a proposition, is enough to make it unattractive to any banker or investor in the States in which this property is well known.

It is really a great temptation to see how fine and perfect a property you can build when you can find some good fellow to put up the price, but I have described the foregoing case to you at length in the hope that the experience of these well known engineers may serve as a warning to you. Build no monuments of engineering skill; monuments are expensive, especially for the party who has to pay for them, and you will usually find that they mark the finish of many an otherwise successful career. You must remember that primarily a railroad is an economic machine intended to build up a community by making a market for its products and by inducing emigration into it, but to accomplish its purpose its rates must remain as low as possible and not be above normal, and that ultimately the territory served by it must pay the cost of securing such service.

Thus you can easily see how a road too well and too expensively built may for a long time be a drain upon the community and really retard growth where it was intended to build up. Even at the present time the most serious handicap upon existing roads and the most serious obstacle to the further development of interurban railways is the heavy construction advised by most engineers and the heavy equipment almost universally recommended by manufacturers.

The promoters and owners of these properties have not generally taken the public into their confidence, and so it is only those who are on the inside and to whom come the frequent appeals for financial assistance, who know the old, old story of elaborate construction, built at tremendous cost, and heavy equipment run at enormous expense, in advance of the development of traffic. Many of these roads have struggled along borrowing the money with which to pay fixed charges and striving to keep out of the hands of a receiver for a year or two longer, in the hope that by that time the traffic will have developed enough to enable them to pay their way.

It is impossible to estimate how much the development of interurban railways has been retarded by these false standards of physical perfection, and the time has come when the interest and rights of bankers and investors whose capital has been tied up in unremunerative projects, are entitled to paramount consideration, and I wish to impress upon you that, as engineers, you have no more right to experiment at the expense of your clients in an undertaking which they expect to be remunerative, than has a physician to take liberties with the body of his patient.

Select equipment that you know will do the work. Be neither the first to adopt a new device, nor the last to abandon an old. It is your duty as engineers to consider first the economic feature of the enterprises submitted to you for your decision or direction. It has been said that there are no physical difficulties with which engineering skill cannot successfully cope. It is merely a question of money. Practically speaking, this is true, and you will find early in your careers that the real question that you have to answer will not be "can it be done," or "how shall it be done," but a really far more important question as to whether the results to be secured will warrant the cost. You should strive to make money for your clients, for by so doing you will not only secure a satisfied clientage, but by building for them profitable and paying plants you will place it within their power to proceed with the building and development of other properties, and so add to the prosperity of the community while making business for yourselves. On the other hand, if you tie up the capital of your client in an unprofitable proposition, you are guilty of an economic crime against the community in which the non-paying investment is made, and you commit a wrong against the man whose further activities you have prevented by placing his capital where he is unable to realize upon it, in addition to losing a client and destroying business for yourselves. A large fee will be cheerfully paid from a successful enterprise out of the operation of which all the stockholders are profiting, while a pittance will be paid grudgingly out of a wreck.

And so, instead of the old standards that have so long prevailed I desire to raise a new and practical standard which recognizes not only the rights of the investor but the economic good of the community in which the investment is made, and so I say to you, "Build not the best, but build the best that will pay."

The advantages of these interurban railways are, however, so great and so apparent that a great many communities are clamoring for their construction, failing to understand why capital does not find their particular locality an attractive place for investment. Such communities usually recognize their need of transportation facilities. They know that their present methods of reaching the markets are expensive, and they see that their farms must remain large because their products are limited to those staples which can be placed in the market without deterioration. They know that the higher values which come from extensive farming and the cutting up of large farms into small tracts cannot be secured until their lands are made accessible. They know too, that capital cannot be expected to build these railways in communities where the population is too small and the possible traffic too limited to support them. But they refuse to believe that these conditions are true of their community, and so, strive earnestly to secure for themselves the benefits of such service by trying to prove that their community is able, even now, to support and make such a proposition profitable. The real difficulty which confronts them is the same as that which confronts so many other parts of the world that are still without means of transportation, and that is, that it is plain that railroads built according to the standards of construction that prevail in communities thickly populated and with a heavy traffic already developed, will not pay for years to come in these thinner populated regions, and because the engineer has not yet been found to construct a road as cheaply as it must needs be constructed for it to pay in such localities. And so further development of interurban railways has largely come to be a question as to whether or not a locality must do without local service because a road costing $40,000 a mile will not pay in that territory, or because it cannot support a road costing say over $20,000 per mile.

The problem of the future is how to cheapen the cost of this facility so as to make possible its wider use, and as it is so much easier to make business than it is to get business, success will largely depend upon ability to devise some plan cheap enough to enable these territories to secure facilities which they must otherwise do without.

In considering a new proposition you should first determine what investment the territory will support. Be assured that the necessary capital is in sight and then plan a completed and earning plant to come within the limits of the proposed investment. It is one of the most common com-

plaints against engineers that the completion of their plans usually costs 50 per cent more than their estimates. As a rule there is nothing so worthless as the "engineers' reports," which the promoters lay before bankers and financiers, unless it be the franchises of which they talk so glibly and for which they claim to have expended such large sums. After the surveys necessary to locate the line, which should not cost much, the first expenditure of money should be for the securing of all the right of way that can be secured without condemnation proceedings, and then suit should be at once instituted against these. The reason for this is, that if an enterprise has any merit in it whatever, its success is assured from the time that it owns a continuous strip of right of way between the proposed terminals, while if it has no merit there is no expenditure that involves less loss, for the fact is that the importance of transportation is so great that there are few real estate holdings that appreciate in value as do these comparatively worthless small tracts when strung together in a continuous line from city to city.

The right of way secured, the next money expended should be for grading. There are two or three good reasons for advising this as the second step. The first is, that there is nothing in connection with railroad work on which you can make a larger and better showing with such a small expenditure of money, as you can in the matter of grading. Then, too, it satisfies your client, for he is able to see results; it satisfies the community, for they realize that work is being done and that a railroad is being built, and nothing goes farther than this in establishing credit for the new enterprise; while most important of all, the possession of a graded right of way is the best insurance of your client against competition or loss, for even if his funds should fail him at this point, it is more than likely that he will be able to turn such an asset into some new company for a profit.

Having gotten thus far, the next step is the purchase of ties and rails, and then with the least expenditure possible on any other account, hurry the laying of track until you can show a continuous pair of rails between your terminals. So many engineers make the mistake of practically completing their track as they go, expending as much in the completion of ten miles, which leads them only half way to the objective point, as would be necessary to reach the objective point if the wiser course had been pursued. The ten miles of track will take you nowhere, but you can ride over the twenty miles from one town to the next even though the going may be rough and slow.

Up to this point you will have been producing real property with the least possible waste. The difference between the 60-pound and 80-pound rail will enable you to save 25 per cent on the investment in steel, and I might say that one of the best interurban roads of which I have any knowledge has been running its cars for nearly twelve years over 50-pound rail that is still without sign of wear or deterioration.

Whatever you use, rail and ties should be the best in quality, for there are no profitable economies in the manner of permanent way, but from this point on you should carefully determine the best that the immediate traffic will support with the least probable loss on account of future replacements, and it will not do to discount the future too much. So many engineers burden a small proposition by attempting to build along with the first mileage a power plant large enough not only for the original proposition, but for all its probable extensions. Now, it is mileage that earns the money, and to burden a small proposition with the capital charge of a heavy power house for which it has no use, simply means to break it financially.

The proper plan is to install units, second hand if possible, no larger than the existing mileage needs for its operation, installing additional units as fast as its growth and extension may make necessary, until the territory has been reasonably covered, and the traffic developed to the point where the mileage can properly use and the earnings carry, the cost of a suitable power house, for when this time comes, the original units are not loss, but may be reinstalled in other places to carry other plants through a similar period of development. There is no other initial economy that pays like this does, for it is rarely possible to anticipate the power demands of a territory, and great loss has frequently been incurred by attempting to do so.

One of the most foolish extravagances is the building of a double track road where a single track will carry all the traffic that can be developed for years to come, for with your right of way and grade, it is a simple matter to supply the second track when the traffic becomes too heavy for the first. So, if you really must build 50 miles of track, and the distance is only 25 miles, find some other place to build the other 25 miles, for it is far better to have two single track roads paying big dividends, than a fine double track proposition that does not earn its fixed charges.

Probably more important even than the question of power is the question of cars and equipment. Cars of from 60 to 70 feet in length, equipped with four motors of from 75 to 100 horsepower each, look very handsome and start up quickly from zero, but they cost about ten thousand dollars apiece, and the amount of power that it takes to move the mere weight of the car is a matter that deserves consideration. One of the best paying properties that I know has for years used a car with 56 seats, measuring 42 feet over all, equipped with only two 35-horsepower motors. These cars are built with firm steel frames, yet are extremely light, and have cost complete, but little over four thousand dollars apiece, yet they take in just as much money as any of the large cars.

It is in this matter of traffic that engineers are more often astray than in anything else, for their desire to make new business too frequently induces them to make estimates not only unsupported by any experience, but in many cases beyond all reason. A recent very glaring instance of this kind has come to my attention where a distinguished firm of engineers, in order to justify the expenditure made necessary by some very heavy construction, and a large amount of difficult bridging, estimated the traffic on a 50 mile road between two large cities at a higher amount per mile than the street railway mileage in those cities had ever taken in, while the fact was that the gross earnings of the road would hardly have been sufficient to pay the fixed charges on its proposed cost.

Two interurban roads running out of Cleveland, Ohio, have 40 and 44 miles of track respectively. The 40 mile road serves about 440,000 people, while the 44 mile road serves about 420,000 people, or only 20,000 less than the first road. With a population so nearly the same the engineers had estimated that the traffic of the second road would be approximately the same as that of the first, but after several years of operation the traffic receipts of the shorter road are still twice as large as those of the longer road, which has now been in the hands of a receiver for several years. The reason for this difference in earnings was, however, understood when upon investigation it was found that 400,000 of the population estimated to be served by each road was in the city of Cleveland itself, while the population served outside of Cleveland was 40,000 in one case and only 20,000 in the other, and that these populations bear the same proportion to each other as do the earnings of the respective roads that serve them.

In estimating the traffic from a proposed interurban road, you will find it unsafe to consider the population of your larger terminus. This larger terminus is extremely necessary for the success of such a road, for you must have some place to which the people along the line desire to go, but you will find that the people of the larger cities have little business and no inclination to leave their large city and ride out to the smaller points along the line, so you must begin by ignoring the population in the large city. You will also find that the much talked of farmer traffic is so small as to be

almost a negligible quantity. The riding population which must be the source of your earnings, you will find to be the population in the villages and towns that you reach, who seek the large terminal for business or pleasure.

For the proper support of an interurban railroad this urban population, outside of the large terminus, should not be less than 750 per mile, and you will find that such a population will yield about five dollars per capita. Such a population will support an electric railway as ordinarily built, paying ordinary fixed charges on a bonded debt, large enough to cover the cost of its construction, but without profit to the promoters or stockholders. In order to be profitable, such a line should have an urban population, outside of the larger terminus, of at least ten hundred per mile of track. Should this population, however, be less than 750 per mile of track, the proposition is likely to prove a financial failure unless built with extraordinary economy.

It is hard to discuss the cost of construction of interurban roads, because so few of them are built with real money. There is so much waste in the methods of the ordinary promoter, and his ways of raising capital are not only expensive, but his lack of credit makes the carrying charges during the period of construction extremely high. If built and paid for with real money these roads should vary in cost from sixteen thousand dollars to twenty-five thousand dollars per mile, according to cost of right of way, weight of rail, and power and equipment used. In no case should they exceed this higher sum unless there exists in the particular place some physical difficulties, such as a large amount of tunnelling, rock cuts, or heavy bridging.

On the other hand, I have known one or two very profitable propositions doing good service in small communities that have been built for less than $15,000 per mile, these sums including in all cases the cost of power house and equipment.

There seems to be little doubt but that the future will see most interurban railways purchased and absorbed by the steam railroad systems whose services they now supplement, for it is natural and right that there should be a unity of transportation interests. The economies of operation brought about by consolidation lessen the tax of transportation, while the economies of time and the relief from transfers brought about by unity of operation, add greatly to the facility of movement.

I have laid particular stress upon the economic value of railways because it is a tremendous relief from the sordidness of life to know that while pursuing your daily tasks you are doing something for your race, and that many may share with you the benefits accruing from the solution of the problem on which you are working. Put your work on a high plane. Consider what it means to this country to reduce the ton-mile cost of transportation a single mill! It would mean the saving to the country annually in carrying charges, the enormous sum of $300,000,000, and this would mean the widening of our markets and the addition of an even larger sum than this, to the annual value of our products and to the wages of labor.

Let it be your pride that you have worked to develop communities; that instead of burdening them with the charge of supporting over-capitalized industries, you have made them to grow and flourish by furnishing them with the facilities that they needed for success, at such a low cost that they have surpassed all other communities similarly situated. Remember that the rewards of labor and the hope of the honest poor may depend on your judgment; that your success may open the door of opportunity to thousands, for it is when you realize that you are doing your share of the world's work that you will be able to approach your task with that enthusiasm and exaltation of soul that compels success.

La Grande, Ore.—An electric line is being built from this place to Union via Cove, a distance of thirty miles.

THE SAN FRANCISCO DISASTER.

The earthquake and conflagration which wrecked and devastated the major portion of the business and residence sections of San Francisco occasioned a very extensive loss to the electrical interests of that city. The street car system of the United Railways suffered very extensively, the converter stations being damaged and the conduits in many places becoming impassable. Certain power stations, however, were reported to be in full operation, and the few cars running were of great service in conveying refugees to the ferries. The Pacific States Telephone Company lost all of its exchanges in San Francisco, and has probably suffered a monetary loss of between £600,000 and £800,000. A new exchange building, costing, with its equipment, at least £100,000, and which was nearly ready for use, was entirely destroyed. One fortunate feature for the electrical interests is that the large building belonging to the Western Electric Company, with all its supplies, was but slightly damaged by the earthquake and fire, and all the stock was saved. These supplies will be a great help to the electrical operating companies, in view of the rapid reconstruction. The buildings of both the Western Union Telegraph Company and the Postal Telegraph Cable Company were destroyed by fire, and all their supplies and instruments lost. The Post-street plant of the San Francisco Gas and Electric Company is reported to be but slightly injured. A fortunate feature of the electric light and power distribution in the city lies in the fact that the major portion of the current comes from the hydraulic stations located in the hills. It is interesting to note that, through the aid of electrical science, the United States Government was enabled to obtain a very satisfactory permanent record of the earthquake. By means of a seismograph located in Washington, records were obtained, through the vibration of a sensitive needle, some thousands of miles from the scene of the greatest activity. The apparatus was recently described in the New York "Electrical Review." An important feature of the apparatus is an electric time marker, the magnet of which is in connection with a circuit closer actuated by a high-grade clock. The circuit is closed momentarily once each minute, and causes a finger to mark a time-stroke each minute on the trace. When an earthquake occurs, all the parts of the instrument partake of the motion of the earth except the lead weight. A contributory lever also remains at rest, and hence the stylus traces on the drum a magnified record of the movement of the ground supporting the instrument.—"Electrical Engineer," London.

APPRENTICE COURSES IN THE LARGE MANUFACTURING COMPANY'S FACTORIES.

Mr. Charles F. Scott discusses in the May issue of the "Electric Journal" the part which apprenticeship plays in the development of an electrical engineer. He rightly lays it down that a theoretical training, however sound it may be, is necessarily narrow if it deals only with purely theoretical and electrical subjects. The true purpose of education is to equip a man with the ability to do things and to train him to apply it himself, and unless a person has had practical factory experience in addition to college training, he is, in subsequent years, placed somewhat at a disadvantage. Apprenticeship affords opportunity for acquiring an intimate knowledge of many of the fundamentals in electrical work, which give a broad foundation for the future. It is impossible for the young student or engineer to foresee the future, or to determine in what succession of relationships his future career may lie. Hence the importance of a training and experience which will be a useful basis in almost any kind of work upon which he may enter. This consideration greatly increases the importance of such institutions as the Association of Technical Institutions of Great Britain, who are endeavoring to bring closer together the heads of manufacturing firms and technical colleges.

INDUSTRIAL.

BROWN-SPEAR-SLOANE COMPANY.

The Brown-Spear-Sloane Company, who have had their temporary office in East Oakland at the factory of the Pacific Steel and Wire Co. for the past three months, have returned to their old location in the Union Trust Building, and are, for the present, located on the second floor. As soon as the building is completely repaired, they will, with their allied companies, occupy the entire third floor of the building. They represent a number of well known Eastern manufacturing companies, among which are the following: The Stromberg-Carlson Telephone Manufacturing Co., of Rochester, N. Y., the well known builders of the Stromberg-Carlson telephone apparatus. In connection with this agency, it is interesting to note that the order for the cables to be used in Tacoma and Portland by the Home Telephone Company was secured by the Brown-Spear-Sloane Company.

Another company which they represent on the Pacific Coast is the American Electric Co., of Phillipsdale, R. I., manufacturers of weather proof wires and cable. Rubber covered cables and wires are handled by them for the Safety Insulated Wire and Cable Co., of Bayon, N. J. Other electrical specialties include the circular loom or flexduct, manufactured by the Osborne Flexible Conduit Co., of New York City, and they also represent the National Metal Moulding Co., manufacturers of iron armoured conduit, located at Economy, Pa., near Pittsburg.

Electrical switches, manufactured by the Hart & Hegeman Manufacturing Co., Hartford, Conn., and incandescent lamps of the Bryan-Marsh Lamp Co., of Cleveland, are also represented by them, and the conduits, bushings and fittings, etc., of the Steel City Electric Co., of Pittsburg, and the conduit boxes, porcelain outlets, etc., of the Crouse-Hinds Electric Co., of Syracuse, are included in their line of supplies. The Holzer Cabot Electric Co., of Boston, manufacturers of annunciators, small motors, etc., are represented on the Coast by this firm.

Besides their home office in San Francisco, they have branches in Los Angeles, in the Pacific Electric Building, of which Garrett H. Youngwright is manager, and in Portland, with offices in the Columbia Building, represented by F. G. Larkin, and in the Alaska Building, Seattle, under the management of H. H. Manny.

They carry a large stock of material in San Francisco and also in Los Angeles and Seattle.

In common with all other enterprising electrical firms, Brown-Spear-Sloane Co. are very much pleased to return to their old offices in San Francisco.

STEAM PIPE COVERING FOR MINING PLANTS.

The H. W. Johns-Manville Co., of 100 William street, New York City, have, for a number of years, been meeting with remarkable success in the installation of their J-M Combination Felt Coverings on pipes in mines and surfaces exposed to extreme weather conditions. In several instances they have demonstrated the feasibility of carrying steam considerably over a mile, having undertaken to accomplish this result even where engineers considered it an impossibility.

The best results are obtained when the J-M Combination Felt Coverings are applied by the manufacturer who maintains a force of thoroughly skilled mechanics for the installation of this covering in all parts of the country.

All tests under actual working conditions prove the J-M Combination Felt Covering to be the most efficient and durable, even when exposed to the most severe conditions.

The H. W. Johns-Manville Co. will be glad to give full information regarding this product to anyone interested.

POWER MACHINERY EXPORTATIONS.

The Westinghouse Machine Co., of East Pittsburg, has recently sold to the United States Government, for use in connection with the Panama railroad, two compound steam engines, one direct connected to a 325 kilowatt 250 volt engine-type generator, and the other to a 200 kilowatt 60-cycle A. C. two-phase 220 volt generator. Both operate under a steam pressure of 150 pounds.

Two 165 brake horse power producer gas engines are to be installed in the plant of the Calgary Milling Company, at Calgary, Alberta, Canada. The engines operate at an altitude of 3,000 feet, using anthracite coal for fuel, with possibility of a change to natural gas as soon as supply is obtained.

G. & O. Braniff & Co. have ordered a 300 kilowatt Westinghouse-Parsons steam turbo-generator unit. The turbine will operate on 150 pound steam pressure and 27 inch vacuum, and will be installed in the plant of S. Roberts & Co., Mexico City, Mexico, generating 50 cycle current at 6,000 alternations.

The Rio Janeiro Tramway, Light & Power Company will install at Rio Janeiro, Brazil, a 300 kilowatt Westinghouse compound engine unit, operating under a steam pressure of 150 pounds, and direct connected to a Westinghouse A. C. generator.

MORE POWER FOR THE CITY OF MONTREAL.

The Montreal Light, Heat & Power Company has undertaken to develop the power at Soulanges Rapids so that the St. Lawrence River, forty miles away, will be made to furnish power for the city's needs. The power house is being erected near Lock No. 4 of the canal. This company has already accomplished much toward the harnessing of the neighboring waterways. It has drawn power from the Lachine Rapids, four or five miles away, the Chambly Rapids on the Richelieu, about seventeen miles away, and the Shawinigan Falls on the St. Maurice, eighty-six miles distant.

The development at Soulanges Rapids is the only plant of similar capacity and class so far designed and built on this continent.

The principal turbines, three in number, are each built for a maximum capacity of 5,350 brake horsepower on the shaft, under a head of fifty feet. Each machine will drive a 3,750 kilowatt generator direct coupled to it. The turbines will be equipped complete with self contained type oil governors for the purpose of securing the necessary speed regulation.

There will be furnished, in addition to the main turbines, two smaller exciter units, each with a capacity of 300 brake horsepower, and operating at a speed of 450 horsepower, M.

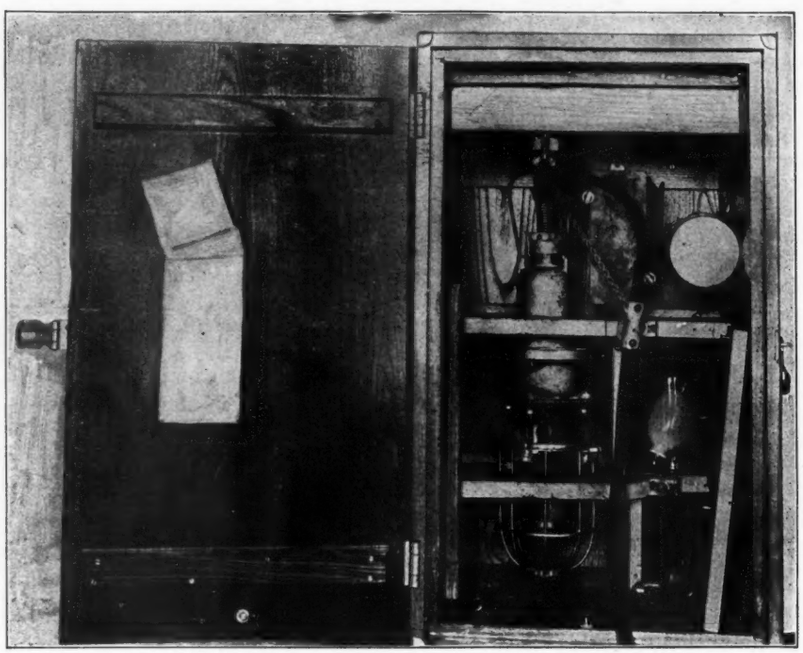
In laying out the power house, ample provision is being made for the addition of another turbine generating unit at some future time. A feature of the hydraulic construction is that used for the draft tubes for the larger units. They will be moulded in concrete, and it is said that this construction will be the first of the kind in Canada. The wheel chambers will be built in concrete and the roadway along the canal will pass over them. It is claimed that with concrete the necessary curves in the tubes can be made to cause less friction than with the ordinary steel or iron penstocks, and that great power can be developed from the given fall of the development.

It is expected that the first main turbine and exciter will be delivered at the power house early in November. The chief engineer in charge of the plant is Mr. Wm. MacLea Wallbank, and the Allis-Chalmers Company will furnish the machinery.

The A. S. Keeler Co., formerly at 90 Second street, have removed their office and warerooms. to 831-833 Folsom street (ground floor).

YALE SUBMARINE ELECTRIC SEARCHLIGHT AND DIVER'S LAMP.

The new Yale Submarine Lamp, made by the Electric Marine Manufacturing Company, 95 Liberty street, New York, is sure to revolutionize the present methods of carrying on diving operations. The invention has passed the experimental stage, having been in practical use for several years by the United States, British, Russian and Italian governments, and the Merritt & Chapman Derrick & Wrecking Company. Work hitherto believed impossible under water has been accomplished with ease and certainty.



YALE SUBMARINE LAMP READY FOR SHIPMENT OR INSTANT SERVICE.

Owing chiefly to the fact that comparatively few intelligent persons have ever ventured to don diving armor and descend below the surface, an air of mystery has come to enshroud the work of the submarine diver. In the shadow of a ship's hull an obstruction, or at depths of fifty feet or over, there exists an impenetrable gloom even with fairly clear water, while in the usual dirty harbor the sun's rays never reach the bottom.

With the Yale Submarine Electric Lamp one need never fear about going down into a black hole where imaginary horrors abound. The yachtsman in search of recreation, or the professional diver, may go down to the bottom and explore or work in perfect ease, for the light from this lamp lights up a space the size of a large room as bright as day.

An outfit for general use shown in one of the illustrations gives an idea of its compactness when stowed in chest ready for shipment or instant service. The lamp, submarine cable, switch, connection box, wrenches, spare parts and supplies are all included in one chest. The Yale Submarine Electric Lamp consists of water tight metallic case inclosing a mechanism and regulator arranged so that when the lamp is submerged it will give forth from the glass chamber at its lower end a most brilliant, clear light, better than the best average street arc lamp. When in use the diver may carry the lamp by means of the circular guard handle, set it down, or suspend it in a convenient manner directly by the cable, no ropes being required. Its weight under water is only a few pounds—just enough to keep in poistion in a current or tideway.

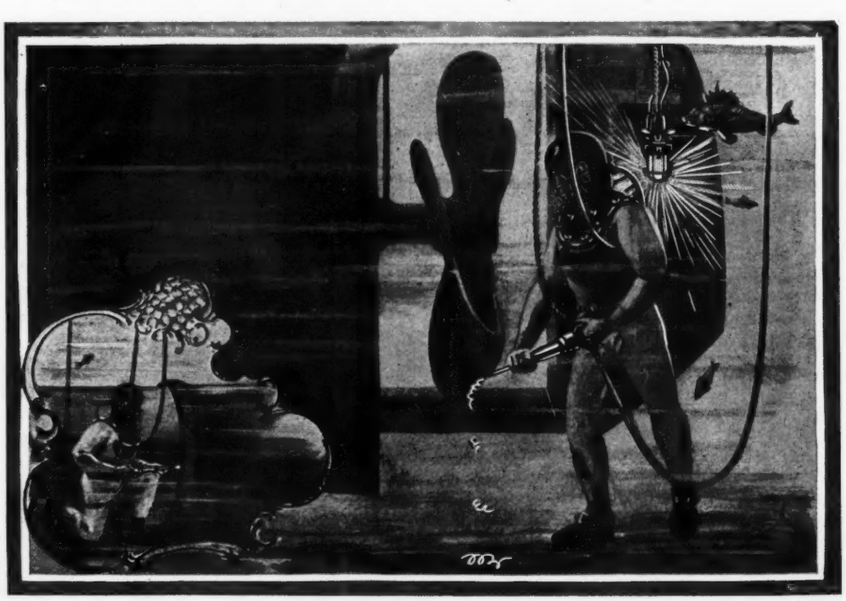
The submarine cable conducting the current to the lamp leads to the surface and thence to a combined junction and switch plate controlled by the diver's attendant. From this plate connection is made to a neighboring electric circuit, storage battery, or small generator outfit supplying the electric power. Compact, of few parts and simple in operation, these submarine outfits afford means for use aboard ship, about a dockyard, mine, water works, engineering construction—in short, wherever a perfect light for use under water or in a gaseous atmosphere is desired.

Exemplified in the naval battles of the Eastern seas were the most modern and up-to-date vessels the world had ever seen, yet it was observed that one after another of the magnificent Russian warships, in spite of all their triumphs of modern equipment, were seen to settle beneath the surface of the Japanese waters.

Fuller investigation has revealed the fact that these splendid ships began, almost from the commencement of the action, slowly but steadily to sink, water entering holes made by "hull shots" of the Japanese gunners. Scarcely any of these shot holes were dangerous to the buoyancy of the vessel at the time they were made, but they kept everlastingly at work letting water into her vitals until at length she became helpless.

Aside from the arrangement of water-tight bulk heads, various protections by cellulose and a few makeshift "stop leak" devices kept on board, there seems to have been no provisions for maintaining the ship's buoyancy constant under fire.

At least one prominent naval power has seen the force of such argument and is bending every energy to alleviate the present imperfect conditions.



YALE SUBMARINE LAMP AND "BOYER" CHIPPING HAMMER OPERATING 20 FT. UNDER WATER.

The solution of the difficulty involves largely submarine operations. Whatever means is taken to close a hole made by shell or torpedo below the water line, repair a sea cock, or propeller requires sooner or later a diver. Diving methods having seldom been resorted to, have remained practically the same as they were forty years ago. That is, when the diver gets a task to perform he gets inside his water tight suit with air tubes attached, is sealed up in it and goes overboard. When he gets down to where the defective part is supposed to be he gropes around in the dark till he finds it and then with the aid of a hammer, crowbar, chisel, or other crude hand tools, and usually by the sense of feeling alone, starts to work. One can imagine that only the simplest makeshift repairs of doubtful permanence may be made under such unfavorable conditions.

Therefore, in order to render the services of a diver of real value in making durable repairs it was found necessary to considerably change the methods of operation and equipment. The question of light, the first step, was solved by the use of the powerful Yale Submarine Electric Lamp, by its inventor, Francis G. Hall; the problem of increasing the workman's efficiency has been attained by Mr. Hall by means of new submarine pneumatic tools, through the collaboration of the Chicago Pneumatic Tool Company, of Chicago, Ill.

The complete equipment is designed to be placed aboard a ship in its own chest ready for use. Every vessel and dockyard in the navies of the chief world powers and many corporations carry a detail of divers more or less expert in the old fashioned methods. These men will be as regularly instructed in the manner of using the new equipment as are the gunners, torpedoists, or caisson men. Schools especially equipped with diving tanks have been just established and the men trained have already some remarkably difficult work in submarine patching, plate and machine work. Letters patent to protect the apparatus have been taken out here and abroad, of which the Electric Marine Mfg. Co. are the sole owners, and the Chicago Pneumatic Tool Company will act as the selling agents of the Yale Submarine Electric Lamps and appliances.

By means of this new invention it will be possible to make permanent repairs, outside as well as inside, the hull of a vessel even under fire. Further, it is predicted that a fleet in cruising trim may be kept fairly clean and in good repair during an extended cruise and without recourse to the dry dock.

What this means can best be appreciated by Admiral Rojestvensky, who was obliged to make frequent costly delays on his long cruise to the Far East, only to arrive with a squadron of battleships encrusted with marine growth and uncertain as to the seaworthiness of the hulls.

ELECTRIC DRIVE FOR SAW MILL.

The application of electricity to nearly every form of industry has been recognized to not only increase the output, but also to decrease the cost of production. Such results, now long since generally accepted, have been demonstrated by actual trials. This is none the less true as applied to the modern wood working machinery of the large planing mills operated in conjunction with many up-to-date saw mills.

A notable example of electric drive for a modern saw mill plant now in process of building is the mill belonging to the Dempsey Lumber Company of Manistee, Mich., located at Tacoma, Washington. This company, which has been operating for over thirty years at Manistee, where their cut was completed last season, has acquired large tracts of standing timber in the State of Washington, sufficient to supply the new mill for many years to come.

Building operations were begun some time ago on the Tacoma mill, which is to be situated in the city of Tacoma on a mill site of about fifty acres area, located on tide water.

The entire equipment for this plant, saw mill, steam and electrical, was purchased from the Allis-Chalmers Company of Milwaukee. The contracts for the saw mill machinery, which were placed some time ago, specify an outfit which will be of the heaviest type that has ever been built. The steam and electrical equipment ordered recently is designed to amply fulfill all requirements of the heavy service contemplated.

The saw mill machinery outfit includes an 11 foot band mill carrying band saws 18 inches wide and a 9 foot band mill having double cut saws of the same width, with a complete equipment of log deck machinery, Pacific Coast carriages, etc., for handling logs up to 10 feet in diameter and 120 feet long. The edger is capable of handling 10 inch timber and is 84 inches wide. The slashers and trimmers will take lumber up to 50 feet in length.

The mill building will be 66 feet wide and about 500 feet long. The power plant will consist of eight 72 inch x 18 feet high pressure boilers with Dutch oven settings, connected to a concrete stack 100 inches in diameter and 120 feet high. A twin engine having cylinders 26 inches in diameter by 36 inch stroke is to be installed separate from the electric plant, which will be driven from separate engines for the generating of power and for lighting purposes, as well as for operating the planing mill, where each machine will be driven from individual motors. The dry kilns will be constructed of concrete blocks, making them perfectly fireproof.

The recently purchased equipment for the electric plant consists of a 22x36-inch Corliss engine directed coupled to a 300 kilowatt, 60 cycle, 3 phase engine type generator, two exciter sets, each of 25 kilowatts, and eleven induction motors of various capacities for driving individual machines.

Two 10 horsepower motors operating at a speed of 1,120 revolutions per minute will drive the trimmer saw. A 30 horsepower motor will be direct coupled to the rip saw running at 680 revolutions per minute. Another 30 horsepower motor will operate a moulding machine running at 850 revolutions per minute, and two 40 horsepower motors will run No. 94 matchers operating at 850 revolutions per minute, to which they will be direct coupled. A band saw running at 690 revolutions per minute will be driven by a 40 horsepower motor, and a 100 horsepower motor will be belted to a blower equipment operating at 680 revolutions per minute. A planer and a twin matcher will each be driven from 50 horsepower machines running at 850 revolutions per minute.

The generator is an engine type machine with revolving field. The armature is stationary and bears the high voltage winding. Each armature coil can easily be taken out and repaired in case of injury, thus insuring continuous operation and minimum loss of time for repairs. The generator is separately excited from an engine-driven exciter with current not exceeding 85 amperes at 120 volts. One exciter is direct coupled to a 440 volt, 3-phase induction motor, while the other is driven from an 8x9-inch New York Safety Engine. The finished plant promises to be in every way the finest ever constructed on the Pacific Coast.

Visalia, Cal.—The Cottonwood Water and Irrigation Company has been incorporated with a capital stock of $75,000 by D. C. Gray, J. D. Martin and B. B. Dudley.

Oakland, Cal.—Mayor Mott, Street Superintendent Ott, and City Engineer Turner are making a personal canvass among the business men of Oakland in favor of the new issue of $568,000 bonds, the proceeds of which are to be devoted to the construction of a new outfall sewer system for the city. The election will take place on September 4th. The money raised by the proposed bond issue will enable the city to lay many main outfall sewers that will be utilized to great advantage when the general reconstruction of the sewer system of the city is begun, as well as giving effective and immediate relief from what the Health authorities consider a dangerous condition.

News Notes.

WASHINGTON NEWS NOTES.

(From our Special Correspondent.)

Spokane, Wash.—Right to every pound of power in the waters of the Pend d'Oreille River between Big Falls, northeast of Spokane, and the International boundary, has been cornered by the Pend d'Oreille Development Company, of which David T. Ham, of Spokane, is president, and George S. Canfield, who has just completed an investigation and preliminary survey, estimated that at least 100,000 horsepower can be developed, with the cost at a minimum compared with other powers. The natural fall of the river through "Z" Canyon is from 60 to 80 feet, and there is a possible fall of approximately 250 feet for power. The concern, which is backed by Spokane capital, purposes building a large plant and transmit power as far north as the boundary.

W. A. White, of New York, who is heavily interested in the Washington Water Power Company, of Spokane, announces that the company's Medical Lake line will soon be extended into the Big Bend country, and it will also supply power for lighting and other purposes to the various towns along the railway. The plant at Post Falls, Idaho, is now in operation, and Mr. White says there is sufficient power to extend the line to Colfax and Palouse, 100 miles, and tap a dozen other towns south of Spokane.

E. P. Coles, of Philadelphia, who is one of the backers of the Lewiston and Southeastern Railway, and E. M. Scofield, C. E., have just returned to Spokane from a trip over the proposed electric line between Lewiston, Idaho, and Grangeville, announce that the railway will be built. It is likely that the Idaho Development Company's plant on the Salmon River will be acquired, when the company will furnish power to the Buffalo Hump mining district in Western Idaho. The railway will tap rich agricultural districts on the Nez Perce and Camas prairies.

R. Cross, of Spokane, president of the Big Bend Water Power Company, recently incorporated for $1,500,000, to develop power on the Spokane River, 28 miles from Spokane, announces that Spokane and Eastern capital is interested in the project, and that a largely increased force will soon be at work on the dams and spillways. It is purposed to build a 60-foot dam, a modern power house, and develop 16,000 horsepower. Mr. Cross says this can be done at a cost of $21.90 the horsepower.

The Hanford Irrigation and Power Company, recently incorporated for $250,000, with J. A. Young, formerly of Spokane, as president, is planning to erect a large power plant at Priest Rapids, where 50,000 horsepower will be developed. It is expected to irrigate 25,000 acres of land in the northeastern part of Benton County, southwest of Spokane, the water coming from the Columbia River.

The Chiwaukum Power and Tunnel Company, headed by O. Gondler, has filed notice at Chiwaukum, west of Spokane, for water rights in the Chiwaukum River. The stream has a drop of more than 2,000 feet the mile for more than nine miles, and it is estimated that 100,000 horsepower is available.

FINANCIAL.

San Francisco, Cal.—The Board of Public Works has decided to ask the Supervisors for $5,000 from bond issue money to build a municipal conduit for phone wires, etc., on Mission street between Sixth and Ninth streets; also between Fifth and Sixth streets.

San Francisco, Cal.—An assessment of one-tenth of a cent per share has been levied on the capital stock of the Alberta Oil Company, payable immediately in this city, delinquent September 22nd, sale day, October 15th.

San Francisco, Cal.—An assessment of $3 per share has been levied by the Spring Valley Water Company for the purpose of providing a fund for the rehabilitation of the plant of the company. There has been violent opposition on the part of a minority of the directors of the company to the levying of an assessment of $3 per share. M. B. Kellogg, attorney for the Spring Valley Company, says that the actual levying of the assessment has been delayed as long as possible out of consideration for the small stockholders. It is reported that another assessment will soon be levied in order to provide sufficient funds with which to complete the restoration of the water company's plant.

INCORPORATIONS.

San Francisco, Cal.—The McCarthy Wireless Telephone Company has been incorporated in this place with a capital stock of $1,000,000 by A. J. Schohay, F. N. Lawn, Otto J. Boss, O. Sufert, H. A. McCarthy, A. E. Bredull, J. H. McCarthy, and F. V. Meyers.

San Francisco, Cal.—The Greyson Gas and Electric Supply Company has been incorporated at this place with a capital stock of $25,000 by A. E. Graupner, W. Mayer, A. Mayer.

Visalia, Cal.—The Central California Water and Irrigation Company has filed a certified copy of articles of incorporation.

Los Angeles, Cal.—The Home Telephone and Telegraph Company, of Santa Barbara, has been incorporated with a capital stock of $200,000 by P. O. Tietzen and R. E. Easton, of Santa Maria, and G. S. Edwards, H. W. T. Ross and E. F. R. Vail, of Santa Barbara.

San Francisco, Cal.—The Bay Point and Clayton Railroad Company has been incorporated at this place with a capital stock of $150,000 by W. H. George, E. V., S. H., I. M., and H. E. Cowell.

Los Angeles, Cal.—The Eagle Water Company has been incorporated with a capital stock of $200,000 by P. F. Schumacher, A .C. Helbrig, W. A. Myers and E. C. Hilliker.

Oakland, Cal.—The People's Water Company has filed articles of incorporation with a capital stock of $20,000,000 by E. A. Heron, George Hazelton, H. Wadsworth, J. H. Spring, Louis Titus, S. M. Marks, and Geo. E. Pratt.

LIGHTING.

Bakersfield, Cal.—Samuel F. Mock, representing B. Baruch, Herman Cohn, Jas. W. Hoolman, and M. N. Newmark, all of Los Angeles, and prospective board of directors and officers of a company which desires to incorporate and furnish the people here and at Kern with gas for lighting and fuel, have petitioned the Trustees recently for permission to lay mains and pipes for a gas-supplying system.

Phoenix, Ariz.—The Hassayampa Sanitarium Company is preparing to install an electric lighting plant at a sanitarium camp to be established very soon.

Pasadena, Cal.—An ordinance has been passed establishing a Municipal Electric Lighting Works department and creating the office of general manager of said department.

El Paso, Texas.—The plan for a complete lighting of the business section has been approved by the city council.